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2006 Evaluation of 4VWX Herring

Évaluation du hareng dans 4VWX en 2006

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ABSTRACT

Landings in the southwest Nova Scotia/Bay of Fundy spawning component in 2005 of 48,900t were substantially (about 30,000t) lower than the previous year due to the reduced quota. There continues to be signs of deterioration in the state of the stock. Age distribution in the catch remained contracted, with a further decline in the proportion of ages 5+ in the fishery. The truncated catch at age and the rapid decline of individual year-classes indicates that total mortality may be considerably higher than estimated. The benefits of the reduced quota in 2005 have not been in place for a sufficient time to be reflected in the biological characteristics of the population.</P><P>

The acoustic survey index from the spawning grounds in 2005 indicates a decline in spawning stock biomass (SSB) from 2004. A population model (calibrated with the German Bank acoustic index) indicates that fishing mortality (F) has been very high in recent years and that the current SSB is less than 100,000t. There has also been little progress towards defined conservation objectives in recent years and none are being met. </P><P>

Landings of 5,260t from the 2005 offshore Scotian Shelf banks by purse seine, midwater and bottom trawl were below average since the fishery was reactivated in 1996. The 2005 fishery was dominated by catches of age 4 and 5 fish. The bottom trawl research survey catches, while reduced in 2005, remain high and herring were widely distributed on banks west of Sable Island. </P><P>

There was an increase in surveyed acoustic biomass in both the Little Hope and Halifax areas after a decline in 2004. A survey with an acoustic recorder was completed for the first time in the Glace Bay area. Recorded landings showed an increase for the Little Hope area and decreases in the other main areas. The Bras d'Or lakes fishery was again closed and there was no sampling from this area. </P><P>

There was a decrease in landings in the traditional New Brunswick weir and shutoff juvenile herring fishery to 13,000t from 20,700t in 2004 and there is a trend of decreasing landings over the past ten years.

RÉSUMÉ

En 2005, les débarquements d'adultes reproducteurs dans le sud-ouest de la Nouvelle-Écosse/baie de Fundy se sont chiffrés à 48 900 t, un nombre sensiblement inférieur (environ 30 000 t) à celui enregistré l'année précédente en raison de la réduction du quota. L'état du stock continue de montrer des signes de détérioration. La fourchette d'âges parmi les prises demeure restreinte, un déclin plus prononcé étant observé pour la proportion des harengs des âges 5+ dans la pêche. La répartition tronquée des prises selon l'âge et la baisse rapide des effectifs par classe d'âge révèlent que la mortalité totale pourrait être considérablement plus élevée que prévu. Les avantages de la réduction du quota en 2005 ne sont pas en place depuis suffisamment longtemps pour qu'ils puissent se refléter sur les caractéristiques biologiques de la population. </P><P>

L'indice des relevés acoustiques réalisés dans les frayères en 2005 indique un déclin de la biomasse du stock de reproducteurs (BSR) par rapport à 2004. Un modèle de population (étalonné d'après l'indice du relevé acoustique sur le banc German) révèle que la mortalité par la pêche a été très élevée ces dernières années et que la BSR actuelle est inférieure à 100 000 t. Au cours des dernières années, il y a eu peu de progrès relativement aux objectifs de conservation établis, et aucun n'a été atteint. </P><P>

En 2005, les débarqueme. :s de 5 260 t réalisés à l'aide de sennes coulissantes, de chaluts pélagiques et de chaluts de fond au large des bancs du plateau néo-écossais ont été inférieurs à la moyenne observée depuis la réouverture de la pêche en 1996. Les prises de 2005 comprenaient principalement des harengs d'âges 4 et 5. Selon les relevés de recherche au chalut de fond, malgré une baisse en 2005, les taux de prises sont demeurés élevés et les harengs étaient très largement répartis sur les bancs à l'ouest de l'île de Sable. </P><P>

La biomasse recensée dans les relevés acoustiques a augmenté tant dans la région de Little Hope que dans celle d'Halifax, après avoir connu un déclin en 2004. On a effectué un relevé au moyen d'un enregistreur acoustique pour la première fois dans la région de Glace Bay. Les débarquements recensés montrent une augmentation dans la région de Little Hope et des baisses dans les autres principales régions. La pêche dans les lacs Bras d'Or a été fermée de nouveau, et il n'y a pas eu d'échantillonnage dans cette région. </P><P>

Au Nouveau-Brunswick, les débarquements de la pêche traditionnelle aux harengs juvéniles à la bordigue et au filet-trappe sont passés de 20 700 t (2004) à 13 000 t, et on constate une tendance à la baisse depuis les dix dernières années.

2006 Evaluation of 4VWX Herring

Introduction

Atlantic herring is a pelagic species found on both sides of the North Atlantic. Herring spawn in discrete locations, to which they are presumed to home. Herring first mature and spawn at three or four years of age (23 to 28 cm or 9 to 11 in), then begin a predictable annual pattern of spawning, overwintering, and summer feeding, which often involves considerable migration and mixing with members of other spawning groups. Most fishing takes place on dense summer feeding, overwintering, and spawning aggregations.

The 4VWX management unit contains a number of spawning areas, separated to various degrees in space and time. Spawning areas in close proximity with similar spawning times, and which share a larval distribution area, are considered part of the same complex. These undoubtedly have much closer affinity than spawning areas that are widely separated in space or time, and do not share a common larval distribution. Some spawning areas are large and offshore, whereas others are small and more localized, sometimes very near shore or in small embayments. The situation is complicated further as herring migrate long distances and mix outside of the spawning period both with members considered part of the same complex and with members of other spawning groups. For the purposes of evaluation and management, the 4VWX herring fisheries are divided into four components (Figure 1):

1. SW Nova Scotia/Bay of Fundy spawning component
2. Offshore Scotian Shelf banks spawning component
3. Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia spawning component; and
4. SW New Brunswick migrant juveniles.

Each component has several spawning areas, and there is mixing of fish among spawning components. Industry and management have explored means of managing the complexity within each component (such as distributing fishing effort among spawning areas according to their relative size) and of taking appropriate account of interaction among components (such as fishing restrictions on some areas of mixing).

Fisheries in the 4VWX area in recent years have been dominated by purse seine, weir and gillnet, with relatively minor landings by shutoff, trap and midwater trawl (Table 1, 2, 3).

Since 1995, the herring stock assessment and related research has been enhanced by a number of projects undertaken with the assistance of the fishing industry. These include industry sampling of biological characteristics of the catch, acoustic surveys using industry vessels and tagging.

The Georges Bank spawning component is not included in this evaluation except to document Canadian fishing activity from that area (Table 1). There were no herring landings in 2005 from the Canadian portion of Georges Bank. This fishery is included in the Gulf of Maine stock complex and has been recently evaluated separately (DFO 2003a, TRAC 2006).

1) Objectives and Management

The 2003-2006 Scotia-Fundy Herring Integrated Fisheries Management Plan (DFO 2003b) sets out principles, conditions, and management measures for the 4VWX herring fisheries. The main principle stated in the plan is "the conservation of the herring resource and the preservation of all of its spawning components".

Three conservation objectives developed and reviewed by Sinclair (1997) appear in the plan:

1)   To maintain the reproductive capacity of herring in each management unit through:

•   persistence of all spawning components in the management unit;

- maintenance of biomass of each spawning component above a minimum threshold;
- maintenance of a broad age composition for each spawning component; and
- maintenance of a long spawning period for each spawning component.

2) To prevent growth overfishing:
- continue to strive for fishing mortality at or below F0.1

3) To maintain ecosystem integrity/ ecological relationships ("ecosystem balance").
- maintain spatial and temporal diversity of spawning
- maintain herring biomass at moderate to high levels

There is evidence that most of these objectives are not being met despite the efforts that have been made in recent years. There is also a need to better define these objectives in terms of minimum thresholds and to explicitly list the spawning components in terms of spatial and temporal expectations.

An "in-season" management process, first implemented in the southwest Nova Scotia fishery during 1995, continued to be used widely within the 4VWX management area (DFO 1997, Stephenson et al. 1996, 1999a). The approach encouraged surveying using the commercial fleet under scientific direction prior to fishing ("survey, assess, then fish" protocol) to ensure that effort was distributed appropriately among various components of the stock (particularly among spawning components) according to the relative size and current state of each component. The use of this approach in recent years has improved data collection and enabled modifications to management decisions to be made with the involvement of participants and on the basis of up-to-date information.

Collaborative research efforts with the fishing industry have been important in recent years. A major portion of the herring industry (including the purse seine sector and major processors) forms the Herring Science Council (HSC), and some members of the fixed gear sector have undertaken a separate Joint Project Agreement with DFO to undertake collaborative scientific projects. The herring industry has continued to provide biological sampling and samples while the purse seine and gillnet sectors undertook key acoustic surveys. Under the auspices of the HSC a dedicated field biologist also takes part in initiatives such as tagging, a summary of fleet activities and analysis of acoustic records from fishing trips.

2) SW NOVA SCOTIA/BAY OF FUNDY SPAWNING COMPONENT

2.1 The Fishery

Herring fishing locations, NAFO unit areas used for catch and sample aggregation, and fishing areas defined by groupings of 10 mile squares (i.e. 10 minute boxes of latitude and longitude) are shown in Figures 2 to 5.

The 2005 catch limit for this component was 50,000t, a further decrease of 33,000t from the previous year (Table 3, Figure 6). Eighty percent of the catch limit was initially allocated to the mobile gear sector and 20% to the fixed gear sector, as has been done historically. Transfer of quota to the mobile fleet occurred late in the season. Most of the catch over the history of this fishery has come from the summer purse seine fishery gear component (Figure 7).

Total landings from this component in 2005 (48,900t) were 29,100t lower than the previous year, and the lowest on record since 1963 (Table 3). Decreased landings by the purse seine sector accounted for most of the decline, with minimal landings by the gillnet sector (566t) and the Nova Scotia weirs (2,245t).

The temporal and spatial distribution of the purse seine fishery was similar to that of the recent decade (average of 1994-2005) for all areas (Table 4-5). The largest purse seine fisheries occurred on German Bank, on summer feeding fish off Long Island, N.S., in the Scots Bay area and around Grand Manan (Figure 5, 8). There was a substantial decrease in the 2005 landings for Scots Bay to 6,240t from the high

of 24,900t recorded for this area in 2004. The German Bank area made up about 30% of the catch for this component with landings of about 14,000t.

During the 1970's and 1980's, a large fishery took place on over-wintering aggregations in Chedabucto Bay. In recent years however, there has been no fishing effort in this area as traditional vessels have been successfully fishing elsewhere. In some years there has been a small fishery on over-wintering herring in January off Halifax Harbor (Chebucto Head), but the majority of the fall and winter herring landings for the past several years have come from the New Brunswick side of the Bay of Fundy and take place from Oct. to Feb. In the 2004-2005 quota year there were 2,030t taken in Oct. and Nov. of 2004 (Table 1, Figure 9).

The summer purse seine fishery took place in the same areas as in previous years (Figure 10). A large part of this fishery was directed on the major spawning grounds in Scots Bay and on German Bank (Figure 11, 12) where recent catches are primarily within the pre-defined acoustic survey catch areas (Melvin and Power 1999). The Trinity Ledge spawning ground, which is still recovering, is closed to purse seine gear from Aug. 15 to Sept. 15 but there were acoustic surveys followed by some catch (443t) by drift gillnet gear (Figure 13). There was only a small drift gillnet fishery of 120t in the Spectacle Buoy area in 2005. This small fishery of <500t has occurred only sporadically in recent years during the month of June. Outside of this component additional catches by drift gillnet gear occurred in Sept. to Oct. in the Little Hope/Port Mouton spawning grounds. There were also set gillnet catches along the Eastern Shore to the east of Halifax and near Glace Bay in Cape Breton (Figure 13).

Catches in the Nova Scotia weirs of 2,245t were higher than the recent lows of 2000 and 2003 but reduced by about 900t from 2004 (Table 3; Figure 14). The annual variation has been attributed to problems in availability of fish to this fixed stationary gear as there continues to be substantial catches by purse seine in the nearby Long Island area on the Bay of Fundy side of Digby Neck. The seasonal timing of the Nova Scotia weir landings has shifted in the last 4 years with a higher proportion of landings now as late as Aug. and Sept. as compared with the traditional early fishery seen in May and June previously (Table 6). Catches in recent years for the Nova Scotia weirs have been highly variable and not as consistent in their amount or timing as in the previous decade. There has been a decline in the total number of herring weirs but the catch per weir (t) for the Nova Scotia weir fishery has remained near average (Table 7).

Catch and Effort

Catch and effort which were examined for gillnet data in the previous assessment showed little trend and are considered unrepresentative due to the very small amount of effort (Power et al., 2004). This trend in reduced catch and effort continued in the 2004 fishing season and so this data was not reexamined.

Purse seine landings make up most of the overall catch and are allocated 80% of the TAC in the SW Nova Scotia/Bay of Fundy component under the current management plan. The purse seine catch has fluctuated between 60,000t and 100,000t since 1989 reflecting changes in the TAC (Table 8, Figure 15). The overall number of boats fishing and days fished has been dropping since 1990 due to fleet rationalization. This has resulted in increases in catch per boat and catch per day in recent years. In general, purse seine catch rates are not considered to reflect trends in population abundance due to the nature of herring schooling behavior, the acoustic technology to find these schools with catch rates remaining high or stable at all stock levels.

2.2 Resource Status

Acoustic Surveys

Automated acoustic recording systems deployed on commercial fishing vessels were used to document the distribution and abundance of Atlantic herring in NAFO Division 4VWX through industry vessel surveys and fishing excursions (Melvin and Power 1999). Regularly scheduled surveys, at approximately

2-week intervals, were conducted on the main spawning components and the spawning stock biomass for each component was estimated by summing these results (Power et al. 2005a, 2006).

In 2005, three surveys were conducted in Scots Bay and three on German Bank, a reduction of one survey from each location in the previous years. Individual survey area coverage was good and consistent with established protocols. Additional acoustic data from fishing nights in Scots Bay and German Bank were examined. At the data input meeting, industry expressed concern about the overall Scots Bay biomass index estimate due to the lateness of the initial survey, time intervals between surveys, the presence of spent fish in catches just prior to the first acoustic survey, and the possibility that some fish may have also come onto the grounds and left between surveys. The spawning fishery period in Scots Bay was reduced from 2004. The duration of the spawning fishery on German Bank was similar to the previous year but began later in August since 2003. No structured surveys occurred on German Bank after October 4.

The documented amount of spawning fish on Trinity Ledge was lower than in the past three years but survey coverage was limited. There were no surveys and no reports of spawning herring on Lurcher Shoal or Seal Island spawning grounds.

The biomass index estimated from acoustic surveys was approximately 233,000t and represents a substantial decline in all areas from recent years (Table 9, Figure 15).

Between 1999 and 2003 acoustic survey results were used as minimum estimates of absolute SSB abundance and the population was considered to be approximately 500,000t. An SSB of that size since the late 1990s would have been expected to result in substantial growth of the population, improved age composition and low fishing mortality, given reasonable recruitment and the landings over that period. The expected growth in the population was not observed in the surveys and increase in proportion of older fish was not observed in either the surveys or the fisheries, and it was noted that the declining proportion of older fish in the population suggested that the total mortality on this stock is high.

The documented amount of spawning fish on Trinity Ledge was again lower but survey coverage was limited. There were no surveys and no reports of spawning herring on the Lurcher or Seal Island spawning grounds.

Spawning ground turnover rates

The current acoustic survey method on spawning grounds is dependent on periodic turnover of spawning fish on the grounds. Acoustic surveys are required to be separated by at least 10 to 14 days to allow for turnover and to prevent double counting (Power et al. 2002). This aspect of the assessment method was the subject of investigation in 2001 and of intensive sampling for maturity stage since the 2002 fishing season. The results are summarized by Melvin et al. (2003, 2004, Power et al. 2005a) and were used to assist in the evaluation of turnover timing and the inclusion or exclusion of specific acoustic surveys.

From 1998 to 2002, the Pelagics Research Council/Herring Science Council, in partnership with Fisheries and Oceans Canada, tagged herring on spawning grounds and on the major Nova Scotia overwintering grounds. Although this project has concluded, tags continue to be returned. The information on tags returned from this study has been summarized by Waters and Clark (2005).

In response to a recommendation from the 2005 RAP, tags were applied to herring on the spawning grounds of Scots Bay and German Bank (Clark, 2006). The results from the tag returns indicated that some tagged herring remained on the spawning grounds for at least 3 weeks after tagging, and in some cases, up to five to six weeks after tagging. As a result, acoustic surveys that were spaced at 2 week intervals were surveying some of the same fish twice. These results also indicated a possible affinity between the fish tagged in Scots Bay and the New Brunswick weirs.

Exploitation Rates on Spawning Grounds

The acoustic survey estimates and catches from individual spawning areas were examined in an attempt to estimate partial exploitation rates for spatially and temporally different spawning groups. This is useful information for assessing the impact of fishing and the relative size of individual spawning units as well as for the overall stock component (Table 10). For this analysis only the three major spawning components (i.e. Scots Bay, German Bank, Trinity Ledge) that have received consistent survey effort were included. Since there are also questions about comparability of acoustic surveys, in terms of the area of survey coverage among years, only data since 1997 are shown and only data since 1999 are included in the overall averages (Table 10-A1). Catches throughout the year from the spawning grounds were assumed to be site specific (Table 10-C1), while catches from all other areas were considered non-spawning and were allocated based on the relative spawning ground SSB proportions (Table 10-A2, C2). In addition the SSB for Seal Island and Spectacle Buoy were allocated to the German Bank spawning area. The exploitation rates were calculated for both the actual catch on the spawning grounds and the overall adjusted catch as Catch / SSB (Table10-P1, P2).

Calculation of exploitation rates by component since 1999 (Table 10, P2) showed that the larger grounds (German Bank and Scots Bay) have an overall exploitation of 14 to 49% for individual areas and years while Trinity Ledge had more variable levels (from 16 to 146%) which may be a problem of catch allocation as well as inconsistent survey effort over the period. The overall exploitation rate for the 4WX stock ranged between 14 and 21%, which are close to the target of $F0.1 = 0.22$ (exploitation of 18%). These rates are dependent on the assumptions that the acoustic survey SSB is complete and that catches have been properly allocated.

Fleet Activity

A summary of daily fishery information compiled by the Herring Science Council and DFO confirmed that the fishery on the SW Nova Scotia/Bay of Fundy component was largely as expected in location and timing, and that there were substantial amounts of herring in some areas other than spawning grounds (Appendix A). In recent years there has been an increase in market for juvenile herring for both lobster bait and to offset a shortfall in weir landings which has been a traditional source of juveniles.

Sampling

Comprehensive biological sampling continued with substantial involvement of the fishing industry. In 2005 a total of 1,240 samples comprising 135,160 fish were measured for length while 5,825 fish were sampled for age. The distribution of samples by gear and month is presented in Table 11. The sources of samples are shown in Table 12 with the bulk of samples coming from the processing industry, has been the case since 1996. Additional samples were collected by: DFO personnel, observers deployed on purse seine vessels and from DFO research surveys. Sampling from the commercial fishery was well matched to the spatial and temporal distribution of the fishery. Additional sampling from research vessel surveys during the spring and summer resulted in widespread geographic coverage as in the past (Figure 16).

Age reading consistency tests

Age reading consistency tests are done in order to evaluate the accuracy and precision of age reading. In 2005 a sub-sample of 143 otoliths were selected from the 2005 collection for the purpose of a within-reader test. There was good representation of the months, areas and gear types sampled during the year. Otoliths were read and then compared to a previous reading. The results show a 93% agreement between the two readings (Table 13). The sum of differences is -2 and the mean coefficient of variation was calculated to be 1.45% (Figure 17).

Catch at Age

Consistent with previous assessments, the catch at age was constructed using the MFD 'Catch at Age' application (version 10.4) which is a Marine Fish Division windows based program for computing catch at

age statistics as part of the stock assessment process. Data files used by 'Catch at Age' were created with the 'CATCHFRM' application that was used to select fish sample data from the Pelagic Samples Database. These data included a 2% adjustment for the shrinkage due to freezing on the length measurements for frozen samples (Hunt et al. 1986). The length-weight relationships, which are also required as input to the 'Catch at Age' application, were calculated using an Oracle SQL*Plus script. The catch at age statistics were then calculated from length frequency and age-length key samples expanded to total catch using appropriate monthly length-weight relationships. The data were grouped or combined and then age-length keys were applied to length frequencies to produce catch at age statistics by NAFO unit area, gear-type and month.

Age Composition of the Catch

Under $F_{0.1}$ fishing and constant average recruitment, the age composition of the population caught in the fishery would be expected to be similar to that shown in Figure 18. There would be peak abundance at age 4, substantial fish surviving older than age 6 and a buildup of fish at ages 11+. This expected or ideal age structure has been used in recent assessments for comparison with the actual catch at age which has been characterized by a predominance of younger ages 2-3 and few fish older than six years old (Stephenson et al. 1999b, 2001, Power et al. 2005b).

The 2001 year-class (at age 4) represented about 40% of the numbers and 52% of the weight of herring landed in the SW Nova Scotia / Bay of Fundy component (Figure 19). The 2002 year-class (at age 3) represented 37% of the numbers and 29% of the weight in the landings. These two year classes were also seen in similar relative proportions in the previous year's fishery and were close to the levels projected by the VPA formulation used in the last assessment.

Age 4 fish were predominant by weight across all gear components except the 4Xs winter purse seine fishery (Jan.-Feb. 2005) which landed mostly age 2 fish (Table 14, Figure 20). The catch at age was also broken down by unit area, month and fishing ground for the purse seine sector which made up the majority of the overall catch (Table 15,16,17; Figure 21-23). Once again, ages 3 and 4 predominated in most areas and months, except for Long Island (area 4Xr) off southwest Nova Scotia where age 2 was the highest by numbers (Figure 23).

The historical time series of catch at age was extended to include the current fishing year and is shown as total number caught as well as percent by age (Table 18-19). The series shows very few fish older than age 7 in recent years and has been dominated by ages 2 through 4 since 1998 (Figure 24, 25). The series is now primarily made up of fish age 6 and younger but older ages were a feature when strong year-classes (i.e. 1976 and 1983) were progressing through the fishery. Age distribution in the catch remained contracted, with a further decline in the proportion of ages 5+ in the fishery (Figure 26). Age 7+ has shown a declining trend since 1990 corresponding to the demise of the 1983 year-class, which was the last very strong year-class in this component. There was an increase in the percentage of age 4's in the catch in 2005 with the influx of the 2001 year class (Figure 26). The rapid decline of year-classes (including the strong 1998 year-class) implies a high total mortality.

Prior to 2005, there was targeting of young fish and the high proportion of juveniles in the catch resulted in reduced yield. As a result of the concern that 2 year olds were being targeted, industry attempted to re-direct to older fish. In 2005, 2 year olds represented only 16% of the catch, a reduction from 36% (Table 19). The total removals of fish by numbers were also reduced by close to 50%.

The trend toward catches at younger ages results in reduced yield and is reflected as an decrease in the average weight of fish in the overall catch at age (Figure 27). This indicator has declined from an average fish weight of 160 to 180g in the 1980's and 1990's to about 100g fish in the current year. These levels have not been observed since 1975, which was just prior to the closure of the meal fishery, the implementation of individual boat quotas and the conversion to a food fishery by the industry (Iles 1993). There is cause for concern for a recruitment fishery on younger ages when there is a lack of knowledge on the size of the incoming year-classes.

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Weight at Age

The average weights at age showed inconsistent trends by age in the most recent five years with ages 1 to 4 declining, ages 5 to 8 increasing, and ages 9 and 10 both up and down (Table 20 and Figure 28), but were within the range of data observed historically (Power and Iles 2001). The most recent 5 year and 10 year average weights at age are consistently lighter than the overall series average (Figure 29) and reflect a general decline in weight at age that occurred for all ages in the mid 1980's.

VPA Analysis

A population model (Virtual Population Analysis, VPA) was fitted to this stock component. The previous assessment (Power et al. 2005b) concluded that the SSB from acoustic surveys summed together results in an overestimate but that as an index of abundance, acoustic surveys follow the biomass trend from the population model. While the discrepancy between the acoustic estimate of absolute SSB abundance and the VPA has not been resolved, there are several potential explanations. A tagging study undertaken in 2005 on both German Bank and Scots Bay confirmed that residence time of a portion of the fish on the spawning grounds may exceed the assumed two week turnover interval. However, adjustments to the acoustic biomass estimates, based on preliminary analysis of the tagging data from Scots Bay, appear to only account for about 40% of the difference between VPA and acoustic estimates. Biomass estimates from single acoustic surveys exceeded total VPA results for the series. The difference is not fully explained by possible double counting by the acoustic surveys, but could also relate to other issues including an inappropriate target strength coefficient for converting backscatter to biomass or unaccounted mortality.

Age specific indices of abundance were constructed from the acoustic survey data using samples appropriate for each survey conducted by area and year for 1999 to 2005 and applying the biomass estimates that were determined (Table 21, Figure 30, 31). These indices were also constructed for the major spawning area, German Bank, separately from the overall (Table 22, Figure 32, 33). These indices were then used as the primary input for tuning or calibration of the VPA. The catch at age from the fishery is also required as input to reconstruct the population history using virtual population analysis (VPA) (Table 18, Figure 25).

Population reconstruction from the catch at age requires some assumptions to be made about conditions in the terminal year. One assumption concerns the exploitation pattern at age (partial recruitment); examination of this pattern since 1990 suggests that an exploitation pattern at age of 0.2, 0.4, 0.7 and 0.9 for ages 2-5 and 1.0 for age 6 and older is a reasonable approximation (Table 23, Figure 34, 35). Other assumptions for the population reconstruction follow traditional approaches from the previous assessment, i.e. M=0.2 and F_{10}=population weighted average for ages 6-9 and to estimate the 1st fully recruited age at age 7 in the terminal year of 2006.

Calculations of total mortality (Z = Fishing mortality + Natural mortality) were calculated using the acoustic catch at age data. Z calculations are typically quite variable but can often be used to detect broad patterns and for confirmation of VPA results. The Z values were calculated using ages 4 to 8 compared with ages 5 to 9 in the following year. The acoustic age composition is assumed to be representative of the overall spawning biomass. The results for 2000 to 2005 have high values of Z between 0.5 and 1.8 (Figure 36). There is no apparent trend as the series is very short; however these values appear consistent with the higher F's estimated from the proportional VPA.

The acoustic survey index from the spawning grounds in 2005 indicates a decline in spawning stock biomass from 2004 (Figure 37). A VPA was calibrated with the trends in acoustic survey results, using fishery catch statistics and sampling for size and age composition of the catch for 1965-2005. Various VPA formulations were investigated and two models were presented for review.

Initial results based on the formulation used in the previous year suggested using only ages 4-8 from the acoustic series since ages 2-3 are considered mostly non-spawning and age 9 and older are so few in number they are poorly estimated (Figure 38-40).

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A VPA model using the overall acoustic survey index (Scots Bay, Trinity Ledge, Spectacle Buoy, and German Bank) calibrated with ages 4 to 8 was examined (Appendix A). Diagnostics for the VPA using the overall acoustic survey index include results for the parameters being estimated by the model (Figure 41). The population abundance at age 7 in 2006 was estimated as 1,543 million with a moderately high standard error of 49% and a low bias of 11%. The other parameters estimated were the Q's or catchabilities for ages 4 to 8 which also had moderate SE's of 29% and low bias of 4%. The trend of increasing Q's at age and the lack of the typical dome or flat-top trend at older ages is unusual and may be due to the short time series and lack of older fish in the population (Figure 41). The pattern of residuals is acceptable with a mixture of moderate size positive and negative residuals (Figure 42). However, there is a strong year effect in 2005 with positive residuals for all ages which may be an indication of a potential future retrospective problem. Age by age and overall combined plots of the observed abundance index and predicted population numbers versus year from VPA run with overall acoustic index for ages 4 to 8 showed a generally decreasing trend over the time series for all ages (Figure 43). Age by age plots of the (ln) observed and (ln) predicted abundance index versus population numbers from a tuned VPA with the overall acoustic index for ages 4 to 8 treated as proportional to population numbers showed reasonable fits for ages 5 to 8 but with some large deviations from the fitted line and with age 2 having a slightly negative relationship of (ln) CPUE with (ln) population abundance (Figure 44). The model showed a slightly declining SSB and total biomass since 1999 (Table 24, Figure 45, 46) and increasing fishing mortality (ages 5 to 8 weighted by population numbers) with a large drop in the current year reflecting the drop in the TAC (Table 25, Figure 47).

The projection input parameters for exploitation rate, natural mortality, partial recruitment, maturities and weights at age which were used for all runs are shown in Table 26. Projection results and risk analysis are provided in terms of the consequences of various catch quotas (yield) (Figure 48). To have a low to neutral risk of exceeding $F=0.2$ requires a catch of about 10,000t. Catches as high as 40,000t will have a neutral chance for 0% biomass change. These results are also shown in terms of exploitation rate and expected biomass change for various yields (Figure 49).

A second population model calibrated with the German Bank acoustic index only was selected to overcome uncertainty with survey timing in Scots Bay (Appendix B). Diagnostics for the VPA using the overall acoustic survey index include results for the parameters being estimated by the model (Figure 50). The population abundance at age 7 in 2006 was estimated as 2,808 million with a moderately high standard error of 47% and a low bias of 9% and was slightly lower than the first model. The other parameters estimated were the Q's or catchabilities for ages 4 to 8 which also had moderate SE's of 30% and low bias of 4%. The trend of increasing Q's at age and the lack of the typical dome or flat-top trend at older ages is unusual and may be due to the short time series and lack of older fish in the population (Figure 50). The pattern of residuals is acceptable with a mixture of moderate size positive and negative residuals (Figure 51). Age by age and overall combined plots of the observed abundance index and predicted population numbers versus year from VPA run with overall acoustic index for ages 4 to 8 again showed a generally decreasing trend over the time series for all ages (Figure 52). Age by age plots of the (ln) observed and (ln) predicted abundance index versus population numbers from a tuned VPA with the overall acoustic index for ages 4 to 8 treated as proportional to population numbers showed reasonable fits for ages 5 to 8 but with some large deviations from the fitted line. The age 2 trend was improved in this formulation having a flat relationship of (ln) CPUE with (ln) population abundance (Figure 53). The model again showed slightly declining SSB and total biomass since 1999 (Table 27, Figure 54, 55) and increasing fishing mortality (ages 5 to 8 weighted by population numbers) with a large drop in the current year reflecting the drop in the TAC (Table 28, Figure 56).

The VPA calibrated with the German Bank indicates that fishing mortality (F) has been very high in recent years and that the current SSB is less than 100,000t (Table 27, Figure 54). Recruitment at age 1 indicates lower than average recruitment in 2003 and 2004 with the 2003 year-class (age 1 in 2004) being relatively weak (Figure 57). Projection results and risk analysis are provided in terms of the consequences of various catch quotas (yield) (Figure 58). To have a low to neutral risk of exceeding $F=0.2$ requires a catch of about 16,000t. Status quo catches would result in no expected increase in biomass. These results are also shown in terms of exploitation rate and expected biomass change for various yields

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(Figure 59). The reduced quota in 2005 resulted in a lowering of F but it is still high relative to $F_{0.1}(0.23)$. The benefits of the reduced quota are reflected in the reduced fishing mortality rate in 2005 but the adjustments have not been in place for a sufficient period to be reflected in the biological characteristics of the population.

Retrospective analysis for the VPA with German Bank acoustic index (ages 4 to 8) with successive years of analysis removed was completed (Figure 60). Results for this analysis of estimation of fishing mortality (F), showed an underestimation of F in recent years but overestimation for some earlier years. Recruitment at age 1 was well estimated for most years going back in time. Beginning of year SSB and beginning of year total biomass estimation was more variable with underestimates in recent years and overestimates in older years. Some of this variability is due to the short length of the survey index and the effect of removing data while doing this analysis.

Fishery catches are considered reasonably reliable and it is not thought that large amounts of unreported catch have occurred in recent years. Age interpretation appears to track strong and weak year-classes historically and there is consistency of age interpretation between and within readers across years.

There is strong support for the interpretation of stock status that the trend in biomass has been flat over recent years and the total biomass is less than half of the acoustic survey estimate. It should be emphasized that the acoustic index only provides information on about 50% of the total biomass with younger ages estimated with average partial recruitment.

This assessment has confirmed a continued deterioration in the state of the resource, as noted in previous assessments. A harvest strategy that allows rapid population rebuilding is strongly recommended. Projection results and risk analysis are provided in terms of the consequences of various catch quotas (yield) (Figure 58). Catches of less than about 16,000t would be required to have a low to neutral probability of exceeding $F_{0.1}$. Catches as high as 35,000t should result in a neutral (50%) probability of a moderate (20%) biomass increase. At status quo (catches of 50,000t) there is a 40% probability that biomass will not increase at all and a high probability (90%) that it will not increase by a moderate (20%) amount.

2.3 Sources of Uncertainty

The benefits of the reduced quota in 2005 have not been in place for a sufficient time to be reflected in the biological characteristics of the population. Industry stated that they took action to avoid young fish in 2005 and the fraction of younger fish removed was substantially reduced.

About half of the catch biomass in recent years has been comprised of ages 2 and 3, and the abundance of these recruiting ages is uncertain. The acoustic index provides independent information on the spawning stock biomass but does not provide data on younger age classes. The size of herring year-classes is highly variable. There is no index of recruitment and thus the initial estimate of year-class size can only be derived from the VPA. Younger ages are derived from the VPA and are based primarily on estimates.

2.4 Ecosystem Considerations

Herring is prominent in the diet of many fish, seabirds and marine mammals, and should be managed with these interactions in mind. At present, use of a natural mortality rate of 0.2 and maintenance of SSB at moderate to high levels are assumed to account for these interactions.

Recent management initiatives to protect spawning components are intended to maintain the spatial and temporal diversity of herring spawning. Increased fishing on juveniles, which are of mixed or unknown stock affinity, is inconsistent with this objective.

2.5 Outlook

Recent assessments of the SWNS/BOF spawning component suggested that fishing mortality should remain below F0.1 (about 20% exploitation rate) for a number of years in order to rebuild spawning stock biomass in all spawning areas and to expand the age composition so as to meet the explicit biological objectives of management.

The 2005 fishery was about 30,000t less than in the previous year. Acoustic surveys showed a substantial decline in SSB to approximately 230,000t, there continues to be deterioration in the state of the stock and some of the conservation objectives specified for this fishery are not being met. There is an absence of older fish in the population and increased targeting of juveniles. While there is spawning on Trinity Ledge and a small amount of spawning has been observed in recent years near Seal Island, the SSB on both Trinity Ledge and Seal Island spawning areas remain well below historical levels.

The rapid decline in year-classes (failure to reach older ages), even in the strong recent 1998 year-class, indicates high total mortality. It seems that the current catch is substantially higher than what would be consistent with a moderate F. Although these high exploitation rates have not resulted in a reduction of surveyed spawning biomass (presumably due to reasonable recruitment), the rebuilding that these recruits may have represented has been lost.

Recent catches have been mostly consistent with the survey, assess, fish protocol of less than 20% of surveyed biomass. However the catch at age indicates that total mortality may be considerably higher. The increased trend to catch juveniles could compromise SSB, expansion of age composition and reoccupation of spawning grounds.

2.6 Management Considerations

An evaluation of progress in recent years against biological objectives in the management plan (DFO 2003b) indicate that most objectives are not being met (Table 29). The German Bank and Scots Bay spawning components have declining biomass estimates and Trinity Ledge, Lurcher Shoal and Seal Island are at low biomass. There was also a delayed start and shorter duration of spawning in 2005 for both Scots Bay and German Bank with insufficient spawning in some areas. This was reflected in a substantial decline in the acoustic index from 2004. There was a further decline in proportion of older ages and the age composition is very narrow, although targeting of small fish was reduced in 2005. Fishing mortality is high and well above $F_{0.1}$ and the SSB is at lowest recorded level.

The in-season management approach, which spreads the effort in the fishery spatially and temporally among spawning components, is seen as beneficial in achieving the conservation objectives. The "survey, assess, then fish" protocol is effective in spreading the catch appropriately among spawning components in proportion to their relative size and is considered an important safeguard.

Acoustic surveys have become critical to stock status evaluation. Surveys conducted in 2005 conformed to the proposed survey design. It is important that there be continued attention to coverage and survey design in order to assure year-to-year consistency in all spawning areas.

3) OFFSHORE SCOTIAN SHELF BANKS SPAWNING COMPONENT

3.1 The Fishery

A foreign fishery during 1963-1973 is estimated to have removed as much as 60,000t per year from the offshore Scotian Shelf banks (Stephenson et al. 1987). Few herring were caught after the extension of jurisdiction in 1977 until 1996, when a fishery was initiated by the 4WX purse seine fleet and 11,700t was taken (Table 3). Since 1996, a fishery has taken place on feeding aggregations on the offshore banks, primarily in May and June, with catches ranging from 1,000 to 20,000t. The variability in catch levels was often due to problems of fish being too deep, weather and market conditions rather than in the abundance of herring in these areas.

Total landings in 2005 were 5,200t with most landings by purse seine in May and June, in the vicinity of the Patch, Emerald and Western Bank (Figure 61). Landings of the 2005 fishery on the Scotian Shelf Banks were again below the nine year average (approx. 9,000t) (Figure 62). In 2005, herring continued to be caught as by-catch in the domestic bottom trawl fishery on the Scotian Shelf edge and slope with 75t reported (Table 1). There was also effort in the late fall by midwater trawlers with 885t caught in the offshore east of the Patch (Table 1).

The 2000 to 2001 year-classes (ages 5 and 4) made up most of the age composition of the Scotian Shelf fishery in 2005, with age 5 dominating in both number and weight (Table 30, Figure 63, 64).

3.2 Research and Industry Surveys

Industry Surveys

Fleet activity/catch in the spring/early summer fishery on the offshore banks of the Scotian Shelf continued to decrease in 2005. Acoustic recorders were activated on a few occasions but insufficient quantities of fish were observed to warrant analysis. Consequently there again were no industry surveys of the area in 2005 and no acoustic biomass estimates were available from the Scotian Shelf (Power et al. 2006).

Herring Larval Survey

An autumn larval herring survey was completed from 1972 to 1998 for a set of fixed location stations in the Bay of Fundy (Table 31). The survey was ended in 1998 but is again presented here for the record.

July Bottom Trawl Survey

Previous results from the summer bottom trawl survey showed few herring on the Scotian Shelf during the 1970's, increasing amounts during the 1980's and a relatively widespread distribution in recent years (Harris and Stephenson 1999, Power et al. 2004, Stephenson et al. 2001). Offshore herring catches from this survey showed a substantial decline from the high in the previous year for strata 55 through 78 (Table 32, Figure 65). Inter-vessel conversion factors established for differences in fishing efficiency by species are being developed from the comparative surveys completed in 2005.

Decreasing trends are also similar for the combined strata from each of the areas 4W and 4X (Table 32, Figure 66). The strata areas used for selection of trawling stations in this bottom trawl survey series are shown in Figure 67. Herring were again widely distributed on banks west of Sable Island (Figure 68) and were comparable to average catches from the last nine years (Figure 69).

The survey data for areas 4WX combined (strata 53/95) were analysed by age to produce stratified mean numbers per tow over the series (Table 33). There was a lack of consistency with the large year-classes observed in the fishery and a lack of tracking of these year-classes from year to year. There have been two major changes in the catch rates by bottom trawl over the series; the first with the introduction of the Alfred Needler in 1987 and a second large increase since 1994. The data by age and year shows a lack of older ages in the catch over the past decade and does not appear to track strong year classes consistently (Table 33).

Fall Herring Research Survey

There has been no fall herring research survey on the Scotian Shelf since 2002 when the research vessel *Alfred Needler* was used to explore the various inshore and offshore areas where herring were known to aggregate.

3.3 Outlook and Management Considerations

The summer bottom trawl research survey demonstrates that there is a considerable abundance of herring widely spread over the offshore banks of the Scotian Shelf. Information from previous assessments indicated the presence of at least some autumn spawning on Western Bank in recent years. There is very little new information to add and no reason to change the previous outlook:

• Recorded landings in the foreign fisheries of 13,000t to 60,000t between 1969 and 1973 did not appear to be sustainable.

• The initial catch allocation for 2005 should not exceed the 12,000t reference value used in the recent fishing plans.

There continues to be insufficient documentation of stock size, distribution and spawning behavior for this component. There have been no industry surveys of the offshore Scotian Shelf area since 2001. Industry, DFO Science and Management are encouraged to continue to work together to improve the biological basis for management. The industry should be encouraged to explore and undertake surveys of the offshore area.

4) COASTAL (SOUTH SHORE, EASTERN SHORE AND CAPE BRETON) NOVA SCOTIA SPAWNING COMPONENT

4.1 The Fishery and Resource Status

There is no quota for the coastal Nova Scotia spawning component and, apart from four areas; the size and historical performance of various spawning groups are poorly documented. In addition to the traditional bait and personal-use fisheries, directed roe fisheries have occurred on several spawning grounds in recent years.

In addition to traditional coastal fixed gear fisheries for subsistence and personal bait, there has been an increase in the number of active gillnet licenses in recent years aimed at spawning herring for the roe market (Clark et al. 1999). As the inshore roe fisheries off Glace Bay, East of Halifax and Little Hope have developed, participants have contributed to sampling and surveying and the fisheries have attempted to follow the 'survey, assess, fish' protocol. This was the tenth year for a fishery on spawning fish off Halifax/Eastern Shore and the ninth year of gillnet roe fisheries off Little Hope/Port Mouton and Glace Bay.

The recorded landings (6,300t) in 2005 in the four major gillnet fisheries along the coast of Nova Scotia were lower for the Eastern Shore and Glace Bay areas, but higher for Little Hope/Port Mouton. The Bras d'Or Lakes fishery remained closed (Table 34).

In 2005, there was an increase in surveyed acoustic biomass in both the Little Hope and Halifax areas after a decline in 2004 (Table 35) (Power et al. 2006). A survey with an acoustic recorder was completed for the first time in the Glace Bay area (previous estimates were based on mapping surveys). As indicated for the SW Nova Scotia / Bay of Fundy component, summing of multiple surveys may result in overestimates of SSB due to double counting. However, the majority of surveys of the Coastal Nova Scotia spawning component were undertaken on spatially separated aggregations of fish.

Management of these spawning components using "survey, assess, then fish (<10%)" protocol is considered useful when the components are considered to be healthy and of sufficient size. The history of the application of this protocol has had some mixed success due to some occasional problems in executing surveys.

Exploitation rates for the coastal areas with acoustic survey estimates have been calculated as the proportion of landings against estimated SSB (Table 36).

Little Hope

The fishery in the Port Mouton/Little Hope area occurred primarily in October with a total of 2239t of herring landed (Figure 70). Sampling indicated that the catch was composed primarily of the 2000 year-class at age 5 (Table 37, Figure 71).

A total of two acoustic surveys took place on the spawning ground on Oct. 4 and Oct. 19, 2005 (Power et al. 2006). The overall acoustic estimate for this area was 39,500t (22% SE).

East of Halifax (4W Eastern Shore)

The roe fishery for the Eastern Shore area in September and October landed 3,400t a decrease of about 700t from 2004 (Figure 72). Sampling was limited to the two survey nights that took place and indicated that the catch was composed of large spawning fish mainly of the 1998 - 2000 year-classes (age 5-7) (Figure 73, Table 37).

Acoustic surveys undertaken by the Eastern Shore Fishermen's Protective Association in September and October 2004 estimated an SSB of 28,100t (16% SE) which was about 10,000t higher than the previous year (Table 35) (Power et al. 2006).

Glace Bay

The fishery off Glace Bay, Cape Breton took place in October with total landings of 630t, which was a large decrease from the previous year (Figure 74, Table 32). Length samples indicated large herring, mostly over 30 cm in total length while maturity samples taken in September were primarily of spawning fish. Fish aged 7 (1998 year-class) dominated the catch (Figure 75, Table 37).

Acoustic survey information was available for 2005 for the first time and recordings were available from two separate occasions. The overall survey estimate from the limited data was 2,200t (Table 35).

Bras d'Or Lakes

The fishery was closed in 2004. No sampling or acoustic surveys were undertaken in the Bras d'Or lakes to document the size distribution or abundance of herring.

4.2 Outlook and Management Considerations

Management approaches and recent research efforts have improved knowledge in these three areas (Little Hope/Port Mouton, Halifax/Eastern Shore and Glace Bay), but there has been no increase in knowledge in adjacent areas. Individual spawning groups within this component are considered vulnerable to fishing because of their relatively small size and proximity to shore. As in the past five years, it is recommended that no coastal spawning areas should experience a large effort increase until much more information is available on the state of that spawning group, and there should be no new fisheries developed when there is uncertainty regarding stock composition and degree of mixing.

It has been noted since 1997 that the status of herring in the Bras d'Or Lakes is cause for concern. Spawning is still absent from some traditional areas and the observed biomass of spring spawners is very low. It is therefore appropriate to reiterate from a biological perspective, that no fishing take place on this spawning component.

5) SW NEW BRUNSWICK MIGRANT JUVENILES

The southwest New Brunswick weir and shutoff fisheries have relied, for over a century, on the aggregation of large numbers of juvenile herring (ages 1-3) near shore at the mouth of the Bay of Fundy.

These fish have been considered to be a mixture of juveniles, dominated by those originating from NAFO Subarea 5 spawning components, and have therefore been excluded from the 4WX quota.

The number and distribution of active weirs have decreased over the past decade, due in part to the conversion of sites to aquaculture, as well as the reduction in landings over the past decade in the Passamaquoddy Bay area (Table 1, 3, 7). In the 2003 there was a large drop in landings in the traditional New Brunswick weir and shutoff fishery to 9,000t - the lowest since 1983 – and there was concern expressed for this fishery. In 2004 weir landings increased to 20,600t (Table 1, 3, Figure 76, 77), the highest since 1994, while in 2005 landings decreased to 13,055 t. There is a trend of decreasing landings in this fishery in the past decade with catches below the 10 year average for 5 of the last 10 years (Table 3, Figure 78).

The 2005 catch was dominated by the 2003 year-class (age 2) in number and the 2002 year-class (age 4) by weight. Mature herring (ages 4+) taken in this fishery are considered to be of 4WX origin (Table 38, Figure 79).

In 2002 the Fundy Weir Fishermen Association, Inc. (FWFA), in partnership with the New Brunswick Department of Agriculture, Fisheries and Aquaculture, the Grand Manan Fishermen's Association, Connors Brothers Ltd. and Fisheries and Oceans, Canada, initiated a tagging program, to be conducted over a three year period. The purpose of this project was to investigate the seasonal movements and migration of herring in the Bay of Fundy with the long-term goal of providing information on stock structure. The application of tags concluded this year and no more tagging is planned by the FWFA. Since the start of this project a total of 123,400 herring have been tagged and 3,840 tags have been recovered to date. The latest results are summarized by Waters (2005).

Preliminary results from tagging studies conducted on weir fish since August 2002 have indicated a link between the fish caught in the weir fishery and those caught in the fall and winter purse seine fishery off Grand Manan. The juvenile fish caught in the purse seine fishery are counted against the 4VWX quota, whilst those caught in the weirs are considered to be of Subarea 5 origin. The recent US management plans (NEFSC 1998, 2004) assumes that all of the juvenile herring from this fishery originate from the US "coastal complex" (5Y + 5Z) which is reported to be at reduced levels of abundance.

6) 5Z Georges Bank

The activities of midwater trawlers and herring purse seiners on the Canadian portion of Georges Bank (area 5Z) were monitored and there were no reported landings (Table 1).

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Table 1. 4VWX herring fishery landings (t) by month, gear sector and management unit for 2004-2005 quota year.

	Area	Gear	1	2	3	4	5	6	7	8	9	10	11	12	Total
S.W. Nova Scotia	4X	Fall P. Seine (2004)										1,404	626		2,030
		Winter P. Seine (2005)	571												571
		Summer P. Seine (2005)					1,445	2,823	13,745	8,952	10,498	6,024			43,487
		Gillnet "Stock"						35	89		443				566
		N.S. Weirs				11	84	731	472	828	118				2,245
S.W. Nova Scotia Total			571	-			1,529	3,589	14,306	9,780	11,058	7,428	626	-	48,899
Coastal Nova	4Vn	Glace Bay Gillnet						0			245	381			626
(South Shore,	4W	Eastern Shore Gillnet									998	2,264	184		3,446
Eastern Shore,	4X	Trap								45					45
Cape Breton)	4X	Little Hope Gillnet						0	0	0	24	2,214			2,239
Coastal Nova Scotia Total								0	0	45	1,267	4,859	184		6,355
Offshore S.S.	4WX	Offshore P. Seine					530	3,689	84						4,303
		Midwater Trawl											697	188	885
		Bottom Trawl + Misc.	0	1	1	2	9	14	8	5	4	13	14	3	75
Offshore S.S. Total			0	1	1	2	539	3,703	92	5	4	13	711	191	5,263
Migrant	4X	N.B. Weirs						213	802	7,145	3,729	740	11		12,639
Juveniles		N.B. Shutoff								118	104	19	134	40	416
Migrant Juveniles Total						-		213	802	7,264	3,833	759			13,055
Georges Bank	5ZE	5Z Purse Seine													-
		Midwater Trawl													
Georges Bank Total										-	-				-

Total 2004-05	73,572

Table 2. 4WX herring fishery landings (t) by month and gear sector for 2005-2006 quota year (as of March 26, 2006).

	Area	Gear	1	2	3	4	5	6	7	8	9	10	11	12	Total
2005-06 quota year	4X	Fall 2005 P. Seine										468			468
		Winter 2006 P. Seine	462												462
	4WX	Bottom Trawl	1	1											2
	4VWX	Midwater Trawl (Stem)	729												729
2005-06 Total (to date)			1,192									468	-		1,661

Table 3. Historical series of nominal and adjusted annual landings (t) by major gear components and seasons of the 4WX herring fishery, 1963-2006 (the 1963-73 Offshore Scotian Shelf landings are from Stephenson et al. (1987)).

Year^	4W Winter Purse Seine	4Xs Fall&Winter Purse Seine	4Xqr Summer Purse Seine	4X Summer Gillnet	4Xr Nova Scotia Weir	4WX Stock Nominal Landings	4WX Stock Adjusted Landings*	4WX Stock TAC	Non-Stock 4Xs N.B. Weir & Shutoff	Offshore Scotian Shelf Banks	Total 4WX Adjusted Landings
1963		6.871	15.093	2.955	5.345	30.264	30.264		29,366	3.000	62.630
1964		15991	24.894	4.053	12.458	57.396	57.396		29.432	2.000	88.828
1965		15.755	54.527	4.091	12.021	86.394	86.394		33.346	6.000	125.740
1966		25.645	112.457	4.413	7.711	150.226	150.226		35.805	2.000	188.031
1967		20.888	117.382	5.398	12.475	156.143	156.741		30.032	1.000	187.773
1968		42.223	133.267	5.884	12.571	193.945	196.362		33.145	18.000	247.507
1969	25.112	13.202	84.525	3.474	10.744	137.057	150.462		26.539	121.000	298.001
1970	27.107	14.749	74.849	5.019	11.706	133.430	190.382		15.840	87.000	293.222
1971	52.535	4.868	35.071	4.607	8.081	105.162	129.101		12.660	28.000	169.761
1972	25.656	32.174	61.158	3.789	6.766	129.543	153.449		32.699	21.000	207.148
1973	8.348	27.322	36.618	5.205	12.492	89.985	122.687		19.935	14.000	156.622
1974	27.044	10.563	76.859	4.285	6.436	125.187	149.670		20.602		170.272
1975	27.030	1.152	79.605	4.995	7.404	120.186	143.897		30.819		174.716
1976	37.196	746	58.395	8.322	5.959	110.618	115.178		29.206		144.384
1977	23.251	1.236	68.538	18.523	5.213	116.761	117.171	109.000	23.487		140.658
1978	17.274	6.519	57.973	6.059	8.057	95.882	114.000	110.000	38.842		152.842
1979	14.073	3.839	25.265	4.363	9.307	56.847	77.500	99.000	37.828		115.328
1980	8.958	1.443	44.986	19.804	2.383	77.574	107.000	65.000	13.525		120.525
1981	18.588	1.368	53.799	11.985	1.966	87.706	137.000	100.000	19.080		156.080
1982	12.275	103	64.344	6.799	1.212	84.733	105.800	80.200	25.963		131.763
1983	8.226	2.157	63.379	8.762	918	83.442	117.400	82.000	11.383		128.783
1984	6.336	5.683	58.354	4.490	2.684	77.547	135.900	80.000	8.698		144.598
1985	8.751	5.419	87.167	5.584	4.062	110.983	165.000	125.000	27.863		192.863
1986	8.414	3.365	56.139	3.533	1.958	73.409	100.000	97.600	27.883		127.883
1987	8.780	5.139	77.706	2.289	6.786	100.700	147.100	126.500	27.320		174.420
1988	8.503	7.876	98.371	695	7.518	124.653	199.600	151.200	33.421		233.021
1989	6.169	5.896	68.089	95	3.308	83.557	97.500	151.200	44.112		141.612
1990	8.316	10.705	77.545	243	4.049	102.627	172.900	151.200	38.778		211.678
1991	17.878	2.024	73.619	538	1.498	97.010	130.800	151.200	24.576		155.376
1992	14.310	1.298	80.807	395	2.227	100.227	136.000	125.000	31.967		167.967
1993	10.731	2.376	81.478	556	2.662	98.464	105.089	151.200	31.573		136.662
1994	9.872	3.174	64.509	339	2.045	80.099	80.099	151.200	22.241		102.340
1995	3.191	7.235	48.481	302	3.049	62.499	62.499	80.000	18.248		80.747
1996	2.049	3.305	42.708	6.340	3.476	58.068	58.068	57.000	15.913	11.745	85.726
1997	1.759	2.926	40.357	6.816	4.019	56.117	56.117	57.000	20.552	20.261	96.930
1998	1.405	1.494	67.433	2.231	4.464	77.027	77.027	90.000	20.091	5.591	102.709
1999	1.235	4.764	64.432	1.660	5.461	77.552	77.552	105.000	18.644	12.646	108.842
2000	1.012	4.738	78.010	823	701	85.284	85.284	100.000	16.829	2.182	104.295
2001	0	4.001	62.004	1.857	3.708	71.570	71.570	78.000	20.209	12.503	104.282
2002	367	5.257	69.894	393	1.143	77.054	77.054	78.000	11.874	7.039	95.967
2003	0	8.860	79.140	439	921	89.360	89.360	93.000	9.003	998	99.361
2004	0	5.659	69.015	225	3.130	78.029	78.029	83.000	20.686	4.165	102.880
2005	0	2.601	43.487	566	2.245	48.899	48.899	50.000	13.055	5.263	67.217

^Annual landings by purse seiners are defined for the period from October 15 of the preceding year to October 14 of the current year.

*Adjusted totals includes misreporting adjustments for 1978-84 (Mace 1985) and for 1985-93 (Stephenson 1993, Stephenson et al 1994)

All landings by other gear types are for the calendar year

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Table 4. Summary of herring purse seine catches (t) from 1984 to 2005 by fishing grounds for 4WX stock and non-stock areas.

Stock Areas	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Avg 94-05
Browns Bank			732						86		1903	1554	40	14	3139	2197	1137	486			45		1168
Chedabucto Bay	490	4216	7498	6374	7523	8325	12470	12596	3084	1378	1407	2049	1759		1583	1151	10						1327
Gannet,Dry Ledge		5675	2187	1474	14901	2010	4213	6294	18527	2935	2588	2693	1963	4590	4156	10296	12674	3877	9047	6965	4456	3117	5535
German Bank		15522	13346	16547	18392	8087	11744	23193	3235	4045	9662	19549	15898	13576	20556	24660	25631	24139	22355	21573	14175	14171	18829
Grand Manan	372	4989	5823	4298	4440	4300	5442	4225	2722	783	6846	5297	6005	5312	15983	7912	18185	10545	17753	17258	7542	5740	10365
Long Island		974	3365	7499	10722	21719	18484	9470	3213	2814	7666	7906	4385	3557	12360	18286	11199	12904	6642	12639	13115	8037	9891
Lurcher		476	132		2928	18	65	151	2141	1560	530	382	243	599	57		715	227	7683	1872	7268	1692	1933
N.B. Coastal	384	188	621	960	1031	3033	2347	488	992	598	99	1502	271	1176	782	1867	361	1250	3113	3914	2707	787	1486
Pollock Point																		1563					1563
S.W. Grounds		558	1108	184	181	276	56	521	225	2961	3444	6205	3035	797	1239	3241	1879	53	791	73		1228	1999
Scots Bay			36	3822	4145	6583	9003	7982	7987	5258	10840	980	8984	4894	8210	1789	10926	10739	8202	19196	24869	6239	9656
Seal Island		13818	8894	11560	19019	23420	25344	12740	10455	3874	2820	465	1567	492	617	567	206	101	238	1096		1358	866
Trinity		35860	13505	18744	18539	266	1113	3259	4612	1348	2366	370	3448	5308	2825	1220	103	113	1609		370	1448	1744
Yankee Bank					194	250	3647	817	119	10	175	323	9	4	159	82	133	8	78			528	150
Unknown	45	184	500	200			200	579	494	140		73			62	84	27			1103	127	181	237
4WX Stock Total	1291	82458	57745	71661	102015	78287	94127	82314	57888	27703	50345	49348	47606	40319	71727	73350	83186	66005	77511	85689	74674	44526	63691

Nonstock Areas	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Avg 94-05
Georges Bank							91	64			266		2491	79			265						775
Liverpool								13		4067	4177												4177
Shelburne			59					64		526	161		56									29	82
Halifax										652	1945		585	455			1002	472	367				689
Offshore Banks													11800	18770	4284	8669	1645	3977	5078	722	4054	4115	6311
Western Hole			41	154				213	3451	2255	1495	108	127	691	1012	1057	47	7712	1884	156		214	1318
Sydney Bight		3511	4250	1751	2100	1330	3591	3606		396		3951	4267		52								2757
Nonstock Total		3511	4291	1964	2100	1330	3682	3959	3451	7896	8044	4059	19325	19995	5348	9726	2958	12161	7329	878	4054	4358	8186

| Overall Total | 1291 | 85968 | 62036 | 73625 | 104116 | 79617 | 97809 | 86273 | 61339 | 35598 | 58389 | 53407 | 66931 | 60314 | 77075 | 83076 | 86144 | 78166 | 84840 | 86567 | 78728 | 48884 | 71877 |

Table 5. Summary of the percentage of herring purse seine catches from 1984 to 2005 by fishing grounds for 4WX stock and non-stock areas.

Stock Areas	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Avg 94-05
Browns Bank			1%						0%		3%	3%	0%	0%	4%	3%	1%	1%			0%		1%
Chedabucto Bay	38%	5%	12%	9%	7%	10%	13%	15%	5%	4%	2%	4%	3%		2%	1%	0%						1%
Gannet,Dry Ledge		7%	4%	2%	14%	3%	4%	7%	30%	8%	4%	5%	3%	8%	5%	12%	15%	5%	11%	8%	6%	6%	7%
German Bank		18%	22%	22%	18%	10%	12%	27%	5%	11%	17%	37%	24%	23%	27%	30%	30%	31%	26%	25%	18%	29%	26%
Grand Manan	29%	6%	9%	6%	4%	5%	6%	5%	4%	2%	12%	10%	9%	9%	21%	10%	21%	13%	21%	20%	10%	12%	14%
Long Island		1%	5%	10%	10%	27%	19%	11%	5%	8%	13%	15%	7%	6%	16%	22%	13%	17%	8%	15%	17%	16%	14%
Lurcher		1%	0%		3%	0%	0%	0%	3%	4%	1%	1%	0%	1%	0%		1%	0%	9%	2%	9%	3%	2%
N.B. Coastal	30%	0%	1%	1%	1%	4%	2%	1%	2%	2%	0%	3%	0%	2%	1%	2%	0%	2%	4%	5%	3%	2%	2%
Pollock Point																		2%					0%
S.W. Grounds		1%	2%	0%	0%	0%	0%	1%	0%	8%	6%	12%	5%	1%	2%	4%	2%	0%	1%	0%		3%	3%
Scots Bay			0%	5%	4%	8%	9%	9%	13%	15%	19%	2%	13%	8%	11%	2%	13%	14%	10%	22%	32%	13%	13%
Seal Island		16%	14%	16%	18%	29%	26%	15%	17%	11%	5%	1%	2%	1%	1%	1%	0%	0%	0%	1%		3%	1%
Trinity		42%	22%	25%	18%	0%	1%	4%	8%	4%	4%	1%	5%	9%	4%	1%	0%	0%	2%		0%	3%	2%
Yankee Bank				0%	0%	4%	1%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%			1%	0%
Unknown	4%	0%	1%	0%			0%	1%	1%	0%		0%			0%	0%	0%			1%	0%	0%	0%
Total	100%	96%	93%	97%	98%	98%	96%	95%	94%	78%	86%	92%	71%	67%	93%	88%	97%	84%	91%	99%	95%	91%	88%

Stock Areas	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Avg 94-05
Georges Bank							0%	0%			0%		4%	0%			0%						0%
Liverpool								0%		11%	7%												1%
Shelburne			0%					0%		1%	0%		0%									0%	0%
Halifax										2%	3%		1%	1%		1%	1%	0%					1%
Offshore Banks													18%	31%	6%	10%	2%	5%	6%	1%	5%	8%	8%
Western Hole			0%	0%				0%	6%	6%	3%	0%	0%	1%	1%	1%	0%	10%	2%	0%		0%	2%
Sydney Bight		4%	7%	2%	2%	2%	4%	4%		1%		7%	6%		0%								1%
Misc Nonstock Total		4%	7%	3%	2%	2%	4%	5%	6%	22%	14%	8%	29%	33%	7%	12%	3%	16%	9%	1%	5%	9%	12%

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Table 6. Monthly weir landings (t) for weirs located in New Brunswick and Nova Scotia; 1978 to 2005.

PROVINCE	YEAR	1	2	3	4	5	6	7	8	9	10	11	12	Year Total
N.B.	1978	3				512	802	5,499	10,275	10,877	4,972	528	132	33,599
	1979	535	96			25	1,120	7,321	9,846	4,939	5,985	2,638	74	32,579
	1980					36	119	1,755	5,572	2,352	1,016	216		11,066
	1981					70	199	4,431	3,911	2,044	2,435	1,686	192	14,968
	1982		17			132	30	2,871	7,311	7,681	3,204	849	87	22,181
	1983					65	29	299	2,474	5,382	3,945	375		12,568
	1984					6	3	230	2,344	2,581	3,045	145		8,353
	1985					22	89	4,217	8,450	6,910	4,814	2,078	138	26,718
	1986	43				17		2,480	10,114	5,997	6,233	2,564	67	27,516
	1987	39	21	6	12	10	168	2,575	10,893	6,711	5,362	703	122	26,621
	1988		12	1	90	657	287	5,993	11,975	8,375	8,457	2,343	43	38,235
	1989		24		95	37	385	8,315	15,093	10,156	7,258	2,158		43,520
	1990					93	20	4,915	14,664	12,207	7,741	168		39,808
	1991					57	180	4,649	10,319	6,392	2,028	93		23,717
	1992				15	50	774	5,477	10,989	9,597	4,395	684		31,981
	1993					14	168	5,561	14,085	8,614	2,406	470	10	31,328
	1994				18		55	4,529	10,592	3,805	1,589	30		20,618
	1995					15	244	4,517	8,590	3,956	896	10		18,228
	1996					19	676	4,819	7,767	1,917	518	65		15,781
	1997				8	153	1,017	6,506	7,396	5,316				20,396
	1998					560	713	3,832	8,295	5,604	525			19,529
	1999					690	805	5,155	9,895	2,469	48			19,063
	2000					10	7	2,105	7,533	4,940	1,713	69		16,376
	2001					35	478	3,931	8,627	5,514	1,479			20,064
	2002					84	20	1,099	6,446	2,878	1,260	20		11,807
	2003					257	250	1,423	3,554	3,166	344	10		9,003
	2004					21	336	2,694	8,354	8,298	913	3		20,620
	2005						213	802	7,145	3,729	740	11		12,639
NB Average Catch (t)		155	34	3	40	140	340	3,857	8,661	5,800	3,086	746	96	22,460
N.S.	1978				1	490	3,704	2,990	239	46	111	198	79	7,858
	1979					811	3,458	1,418	420	39	136	57		6,339
	1980					69	647	1,271	395					2,383
	1981					50	437	983	276	37		41		1,824
	1982					16	267	468	195	172	12			1,130
	1983				2	286	141	188	208	53		18		896
	1984					113	1,032	736	602	220				2,702
	1985					378	1,799	1,378	489			11		4,055
	1986					385	403	71	704	390	5			1,957
	1987					1,503	2,526	1,215	1,166	367				6,776
	1988					1,217	2,976	1,696	1,204	386				7,480
	1989					340	1,018	870	843	226				3,296
	1990					208	973	1,482	879	538	52			4,132
	1991				3	23	149	719	342	262				1,498
	1992					35	659	405	754	371				2,224
	1993					226	908	608	867	53				2,662
	1994					111	736	499	519	180				2,045
	1995					236	1,255	1,059	470	29				3,049
	1996					430	1,267	1,232	358	188				3,476
	1997					70	1,874	1,739	271	65				4,019
	1998					1,304	1,677	390	359	317				4,048
	1999					1,958	1,513	547	488	31				4,537
	2000						16	151	326	191				683
	2001					105	1,439	1,565	391	207				3,708
	2002					23	95	240	558	228				1,143
	2003					98	126	68	344	284				921
	2004						667	873	1,370	219				3,130
	2005				11	84	731	472	828	118				2,245
NS Average Catch (t)					5	406	1,160	905	567	201	63	65	79	3,222

Table 7. Overall effort from New Brunswick and Nova Scotia weirs for catch (t), number of active weirs and the catch per weir (t) for the period 1978 to 2005.

Year	Annual Catch (t) NB	NS	Total Catch	No. Active Weirs NB	NS	Total No.	Catch per weir (t) NB	NS	Average
1978	33,599	7,858	41,458	208	31	239	162	253	173
1979	32,579	6,339	38,918	210	27	237	155	235	164
1980	11,066	2,383	13,449	120	29	149	92	82	90
1981	14,968	1,824	16,793	147	28	175	102	65	96
1982	22,181	1,130	23,311	159	19	178	140	59	131
1983	12,568	896	13,464	143	23	166	88	39	81
1984	8,353	2,702	11,056	116	13	129	72	208	86
1985	26,718	4,055	30,774	156	14	170	171	290	181
1986	27,516	1,957	29,473	105	18	123	262	109	240
1987	26,621	6,776	33,397	123	21	144	216	323	232
1988	38,235	7,480	45,715	191	21	212	200	356	216
1989	43,520	3,296	46,817	171	20	191	255	165	245
1990	39,808	4,132	43,940	154	22	176	258	188	250
1991	23,717	1,498	25,216	143	20	163	166	75	155
1992	31,981	2,224	34,206	151	12	163	212	185	210
1993	31,328	2,662	33,990	145	10	155	216	266	219
1994	20,618	2,045	22,662	129	11	140	160	186	162
1995	18,228	3,049	21,277	106	10	116	172	305	183
1996	15,781	3,476	19,257	101	12	113	156	290	170
1997	20,396	4,019	24,415	102	15	117	200	268	209
1998	19,529	4,048	23,577	108	15	123	181	270	192
1999	19,063	4,537	23,600	100	14	114	191	324	207
2000	16,376	683	17,058	77	3	80	213	228	213
2001	20,064	3,708	23,772	101	14	115	199	265	207
2002	11,807	1,143	12,950	83	9	92	142	127	141
2003	9,003	921	9,924	78	8	86	115	115	115
2004	20,620	3,130	23,750	84	8	92	245	391	258
2005	12,639	2,245	14,884	76	10	86	166	225	173
Average	22,460	3,222	25,682	128	16	144	175	210	179

Table 8. Purse seine effort, catch and CPUE levels for 1989 to 2005.

Year	No. Days Fished	No. of Boats Fishing	Total Catch t	CPUE (catch/slip)	CPUE (catch/boat)
1989	2198	40	87,383	40	2185
1990	2390	42	103,537	43	2465
1991	2333	40	88,830	38	2221
1992	2431	39	95,072	39	2438
1993	2542	36	92,828	37	2579
1994	2227	36	75,652	34	2101
1995	1682	32	56,441	34	1764
1996	1781	32	60,038	34	1876
1997	1731	30	61,769	36	2059
1998	2290	28	70,931	31	2533
1999	1775	28	78,574	44	2806
2000	1572	28	78,727	50	2812
2001	1826	21	75,343	41	3588
2002	1838	19	76,210	41	4011
2003	1652	18	85,499	52	4750
2004	1358	18	76,361	56	4242
2005	945	16	48,517	51	3032

Table 9. Summary of the spawning stock biomass for each of the surveyed spawning grounds in the Bay of Fundy/SW Nova component of the 4WX stock complex (from Power et al. 2006).

Location/Year	1997*	1998*	1999	2000	2001	2002	2003	2004	2005	Average 1999-2005
Scots Bay	160,200	72,500	41,000	106,300	163,900	141,000	133,900	107,600	16,800	101,500
Trinity Ledge	23,000	6,800	3,900	600	14,800	8,100	14,500	6,500	5,100	7,643
German Bank	370,400	440,700	460,800	356,400	190,500	393,100	343,500	367,600	211,000	331,843
Spectacle Buoy										
- Spring	15,000	1,300	0	0	1,100		1,400	n/s	300	560
- Fall					87,500					87,500
Sub-Total	568,600	521,300	505,700	463,300	457,800	542,200	493,300	481,700	233,200	453,886
Seal Island					3,300	1,200	12,200			5,567
Browns Bank					45,800					45,800
Total	568,600	521,300	505,700	463,300	506,900	543,400	505,400	481,700	233,200	462,800
Overall SE t	n/a	n/a	94,600	64,900	50,800	49,500	86,100	74,200	64,900	69,286
Overall SE %	n/a	n/a	19	14	10	9	17	15	28	16

*Biomass estimates prior to 1999 are not considered comparable due to variation in the coverage area.

Table 10. Partial exploitation rates (%) by major spawning grounds and for the overall Bay of Fundy/SW Nova component of the 4WX stock complex with (A1) acoustic survey SSB, (A2) acoustic survey proportion of total SSB, (C1) allocated catch by spawning component, (C2) adjusted catch including non-spawning area catches, exploitation rate as percentage of acoustic SSB for (P1) spawning area catch and (P2) adjusted catch.

A1) Acoustic Survey SSB (t)	1997	1998	1999	2000	2001	2002	2003	2004	2005	Avg 99-05
Scots Bay	160,168	72,473	40,972	106,316	163,900	141,000	133,900	107,600	16,800	101,498
Trinity	23,000	6,762	3,885	621	14,800	8,100	14,500	6,500	5,100	7,644
German Bank	385,400	442,033	460,823	356,372	282,400	394,357	357,100	367,600	211,000	347,093
Total SSB	568,568	521,268	505,680	463,309	461,100	543,457	505,500	481,700	232,900	456,235

A2) Acoustic Survey Proportions	1997	1998	1999	2000	2001	2002	2003	2004	2005	Avg 99-05
Scots Bay	28%	14%	8%	23%	36%	26%	26%	22%	7%	21%
Trinity	4%	1%	1%	0%	3%	1%	3%	1%	2%	2%
German Bank	68%	85%	91%	77%	61%	73%	71%	76%	91%	77%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

C1) Catch by Spawn Area	1997	1998	1999	2000	2001	2002	2003	2004	2005	Avg 99-05
Scots Bay	4,894	8,210	1,789	10,926	10,739	8,202	19,196	24,869	6,239	11,709
Trinity (purse seine+gillnet)	8,820	4,512	2,526	843	1,271	1,865	369	595	2,014	1,355
German Bank	13,576	20,556	24,660	25,631	24,139	22,355	21,573	14,175	14,171	20,958
Spawn Area Total	27,290	33,278	28,974	37,400	36,149	32,422	41,138	39,639	22,424	34,021
Overall SW Nova Catch	56,117	77,027	77,552	85,284	71,570	77,054	89,461	78,029	48,981	75,419

C2) Adjusted Catch by Area	1997	1998	1999	2000	2001	2002	2003	2004	2005	Avg 99-05
Scots Bay	13,015	14,293	5,725	21,914	23,330	19,782	31,996	33,444	8,155	20,621
Trinity	9,986	5,080	2,899	907	2,408	2,530	1,755	1,113	2,596	2,030
German Bank	33,116	57,655	68,929	62,462	45,832	54,742	55,710	43,472	38,231	52,768
Adjusted Catch Total	56,117	77,027	77,552	85,284	71,570	77,054	89,461	78,029	48,981	75,419
Overall SW Nova Catch	56,117	77,027	77,552	85,284	71,570	77,054	89,461	78,029	48,981	75,419

P1) Percentage (C1/SSB)	1997	1998	1999	2000	2001	2002	2003	2004	2005	Avg 99-05
Scots Bay	3%	11%	4%	10%	7%	6%	14%	23%	37%	15%
Trinity	38%	67%	65%	136%	9%	23%	3%	9%	39%	41%
German Bank	4%	5%	5%	7%	9%	6%	6%	4%	7%	6%
Overall (C1/SSB)	5%	6%	6%	8%	8%	6%	8%	8%	10%	8%

P2) Percentage adjusted (C2/SSB)	1997	1998	1999	2000	2001	2002	2003	2004	2005	Avg 99-05
Scots Bay	8%	20%	14%	21%	14%	14%	24%	31%	49%	24%
Trinity	43%	75%	75%	146%	16%	31%	12%	17%	51%	50%
German Bank	9%	13%	15%	18%	16%	14%	16%	12%	18%	15%
Overall Adjusted (C2/SSB)	10%	15%	15%	18%	16%	14%	18%	16%	21%	17%

Table 11. Summary of biological samples by gear and month as collected during the 2005 4VWX herring fisheries. 'NO_LF' is the number of length frequency samples collected, 'NO_MEAS' is the number of length frequency fish measured and 'Aged' is the number of detail fish with age determined.

Gearname	Data	Month												Grand Total
		1	2	3	5	6	7	8	9	10	11	12	
4W Purse Seine	Sum of No. LF Samples				1	23	1						25
	Sum of No. Measured				158	2,939	153						3,250
	Sum of No. Aged				-	-	-						-
5Y CAN P.Seine	Sum of No. LF Samples					10	29		1	9			49
	Sum of No. Measured					1,085	4,243		118	1,049			6,495
	Sum of No. Aged					57	100		-	136			293
5Y USA P.Seine/MWT	Sum of No. LF Samples				5	11		1	1	2	23	9	52
	Sum of No. Measured				552	1,305		115	124	254	2,732	1,100	6,182
	Sum of No. Aged				-	-		-	-	-	-	-	-
5Z USA P.Seine/MWT	Sum of No. LF Samples	24	40	18							3		85
	Sum of No. Measured	2,752	4,422	2,172							379		9,725
	Sum of No. Aged	-	-	-							-		-
Gillnet	Sum of No. LF Samples								5	9			14
	Sum of No. Measured								1,510	762			2,272
	Sum of No. Aged								114	44			158
N.B. Purse Seine	Sum of No. LF Samples	9				3	26	3		8			49
	Sum of No. Measured	600				345	3,146	272		728			5,091
	Sum of No. Aged	122				-	40	21		76			259
N.B. Shut-off	Sum of No. LF Samples							2	4		3		9
	Sum of No. Measured							262	423		347		1,032
	Sum of No. Aged							27	-		42		69
N.B. Weirs	Sum of No. LF Samples					1	38	178	126	25	3		371
	Sum of No. Measured					138	4,931	22,679	14,807	2,996	353		45,904
	Sum of No. Aged					26	102	356	268	79	20		851
N.S. Purse Seine	Sum of No. LF Samples				14	66	90	80	91	27			368
	Sum of No. Measured				1,736	8,066	11,274	10,153	11,592	3,280			46,101
	Sum of No. Aged				59	221	244	1,068	642	155			2,389
N.S. Weirs	Sum of No. LF Samples				1	31	10	11	1				54
	Sum of No. Measured				118	3,855	1,271	1,419	111				6,774
	Sum of No. Aged				-	253	73	141	-				467
Resrch. Otter Trawl	Sum of No. LF Samples		9	30		15	98						152
	Sum of No. Measured												
	Sum of No. Aged		64	275		151	804						1,294
Midwater Trawl	Sum of No. LF Samples										9	3	12
	Sum of No. Measured										1,817	516	2,333
	Sum of No. Aged										45	-	45
Total Sum of No. LF Samples		33	49	48	21	160	292	275	229	80	41	12	1,240
Total Sum of No. Measured		3,352	4,422	2,172	2,564	17,733	25,018	34,900	28,685	9,069	5,628	1,616	135,159
Total Sum of No. Aged		122	64	275	59	708	1,363	1,613	1,024	490	107	-	5,825

Table 12. Number of herring samples collected by DFO personnel from commercial fisheries (Commercial), by members of the fishing industry (Industry), observer program (Observer), independent observers on foreign vessels (OSS) and DFO research surveys (Research).

Year	Commercial	Industry	Observer	OSS	Research	Total
		Sample Source				
1990	422			185		607
1991	448			167	1	616
1992	330			205	1	536
1993	183			421		604
1994	223			228	14	465
1995	138			244	108	490
1996	127	868	49		69	1,113
1997	78	1,443			114	1,635
1998	225	1,376			98	1,699
1999	49	1,388	89		198	1,724
2000	34	1,387	108		177	1,706
2001	47	1,455	96		190	1,788
2002	17	1,339	84		181	1,621
2003	58	1,292	56		199	1,605
2004	50	1,270	60		105	1,485
2005	48	1,017	23		152	1,240
Average	155	1,284	71	242	115	1,183

Table 13. Agreement in 2005 age determinations between aged and re-aged herring.

read1	read2	1	2	3	4	5	6	7	8	Total
1		25								25
2			25	1						26
3				27						27
4				1	25	1				27
5						19	2			21
6						2	6	1		9
7								1		1	2
8									6	6
Total		25	25	29	25	22	9	1	7	143

agreement = 93%

Table 14. Herring catch at age for the 2005 purse seine, gillnet and weir fisheries conducted on the SW Nova Scotia/Bay of Fundy spawning component (4WX stock).

SW Nova Scotia Stock	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	135	72,039	171,155	180,893	28,030	4,286	1,050	49	2	2	-	457,640
% numbers	0%	16%	37%	40%	6%	1%	0%	0%	0%	0%	0%	100%
Catch wt. (t)	3	2,502	14,250	25,487	5,366	996	278	15	1	1	-	48,898
% catch wt.	0%	5%	29%	52%	11%	2%	1%	0%	0%	0%	0%	100%
Avg. len (cm)	14.4	17.2	22.9	26.5	29.1	30.9	32.0	33.5	34.0	35.0		23.9
Avg. wt. (g)	19.2	34.7	83.3	140.9	191.4	232.5	264.5	306.2	321.9	364.9		106.8

Catch Numbers (000's)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Fall P. Seine (2004)	0	226	23,464	8,251	1,200	92	5	2	0	0	0	33,241
Winter P. Seine (2005)	0	9,624	11,282	0	0	0	0	0	0	0	0	20,906
Summer P. Seine (2005)	135	53,206	127,888	162,701	25,352	3,852	924	41	1	1	0	374,101
Gillnet "Stock"	0	0	95	3,347	178	66	3	0	0	0	0	3,689
N.S. Weirs	0	8,982	8,426	6,594	1,299	275	119	7	2	0	0	25,703
Total Numbers by Age	135	72,039	171,155	180,893	28,030	4,286	1,050	49	3	1	0	457,640

% Numbers	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Fall P. Seine (2004)	0%	1%	71%	25%	4%	0%	0%	0%	0%	0%	0%	100%
Winter P. Seine (2005)	0%	46%	54%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Summer P. Seine (2005)	0%	14%	34%	43%	7%	1%	0%	0%	0%	0%	0%	100%
Gillnet "Stock"	0%	0%	3%	91%	5%	2%	0%	0%	0%	0%	0%	100%
N.S. Weirs	0%	35%	33%	26%	5%	1%	0%	0%	0%	0%	0%	100%
Percent Numbers by Age	0%	16%	37%	40%	6%	1%	0%	0%	0%	0%	0%	100%

Catch Weight (t)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Fall P. Seine (2004)	0	3	1,058	797	154	16	1	0	0	0	0	2,030
Winter P. Seine (2005)	0	164	407	0	0	0	0	0	0	0	0	571
Summer P. Seine (2005)	3	2,069	12,106	23,233	4,921	899	244	13	0	0	0	43,487
Gillnet "Stock"	0	0	12	504	33	16	1	0	0	0	0	566
N.S. Weirs	0	267	666	953	257	66	32	2	1	0	0	2,244
Total Weight (t) by Age	3	2,502	14,250	25,487	5,366	996	278	15	1	0	0	48,898

% Catch Weight	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Fall P. Seine (2004)	0%	0%	52%	39%	8%	1%	0%	0%	0%	0%	0%	100%
Winter P. Seine (2005)	0%	29%	71%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Summer P. Seine (2005)	0%	5%	28%	53%	11%	2%	1%	0%	0%	0%	0%	100%
Gillnet "Stock"	0%	0%	2%	89%	6%	3%	0%	0%	0%	0%	0%	100%
N.S. Weirs	0%	12%	30%	42%	11%	3%	1%	0%	0%	0%	0%	100%
Percent Weight by Age	0%	5%	29%	52%	11%	2%	1%	0%	0%	0%	0%	100%

Table 15. Herring catch at age by NAFO unit area for the 2005 summer purse seine fishery conducted on the SW Nova Scotia/Bay of Fundy spawning component (4WX stock).

Summer Purse - overall	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	135	53,206	127,888	162,701	25,352	3,852	924	41	1	1		374,101
% numbers	0%	14%	34%	43%	7%	1%	0%	0%	0%	0%		100%
Catch wt. (t)	3	2,069	12,106	23,233	4,921	899	244	13	0	-		43,487
% catch wt.	0%	5%	28%	53%	11%	2%	1%	0%	0%	0%		100%
Avg. len (cm)	14.4	17.9	23.4	26.5	29.1	30.8	32.0	33.5	35.0	35.0		24.4
Avg. wt. (g)	19.2	38.9	94.7	142.8	194.1	233.3	263.7	308.8	365.5	365.5		116.2

5Yb Purse	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	41	23,373	12,175	1,243	97	6	-	-	-		36,934
% numbers	0%	0%	63%	33%	3%	0%	0%	0%	0%	0%		100%
Catch wt. (t)	-	2	2,214	1,700	243	23	1	-	-	-		4,183
% catch wt.	0%	0%	53%	41%	6%	1%	0%	0%	0%	0%		100%
Avg. len (cm)	-	19.4	23.4	26.3	29.1	30.7	31.6	-	-	-		24.6
Avg. wt. (g)	-	50.2	94.7	139.6	195.5	234.8	258.3	-	-	-		113.3

4Xs Purse	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	42	598	14,561	7,759	555	121	4	-	-	-		23,641
% numbers	0%	3%	62%	33%	2%	1%	0%	0%	0%	0%		100%
Catch wt. (t)	1	25	1,385	1,056	108	29	1	-	-	-		2,604
% catch wt.	0%	1%	53%	41%	4%	1%	0%	0%	0%	0%		100%
Avg. len (cm)	13.2	18.3	23.4	26.1	29.0	30.9	32.0	-	-	-		24.3
Avg. wt. (g)	14.3	41.4	95.1	136.1	194.3	236.4	270.6	-	-	-		110.1

4Xr Purse	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	92	49,236	47,464	45,108	5,546	1,006	211	12	-	-		148,676
% numbers	0%	33%	32%	30%	4%	1%	0%	0%	0%	0%		100%
Catch wt. (t)	2	1,883	4,190	6,252	1,090	237	57	4	-	-		13,714
% catch wt.	0%	14%	31%	46%	8%	2%	0%	0%	0%	0%		100%
Avg. len (cm)	15.0	17.8	22.9	26.3	29.2	30.8	32.1	33.1	-	-		22.5
Avg. wt. (g)	21.5	38.2	88.3	138.6	196.6	235.3	269.8	304.5	-	-		92.2

4Xqpo Stock Purse Seine	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	3,331	42,490	97,659	18,008	2,629	703	29	1	1		164,850
% numbers	0%	2%	26%	59%	11%	2%	0%	0%	0%	0%		100%
Catch wt. (t)	-	159	4,317	14,225	3,480	611	184	9	0	0		22,986
% catch wt.	0%	1%	19%	62%	15%	3%	1%	0%	0%	0%		100%
Avg. len (cm)	-	19.1	23.9	26.7	29.1	30.9	32.0	33.6	35.0	35.0		26.2
Avg. wt. (g)	-	47.8	101.6	145.7	193.2	232.3	261.9	310.5	365.5	365.5		139.4

Table 16. Herring catch at age by month for the 2005 summer purse seine fishery conducted on the SW Nova Scotia/Bay of Fundy spawning component (4WX stock).

May - P. Seine	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	903	14,002	2,787	214	21	3	-	-	-	-	17,930
% numbers	0%	5%	78%	16%	1%	0%	0%	0%	0%	0%	0%	100%
Catch wt. (t)	-	37	1,007	356	39	5	1	-	-	-	-	1,445
% catch wt.	0%	3%	70%	25%	3%	0%	0%	0%	0%	0%	0%	100%
Avg. len (cm)	-	18.4	22.0	26.1	29.0	31.2	31.5	-	-	-		22.5
Avg. wt. (g)	-	41.0	71.9	127.9	180.9	231.2	240.0	-	-	-		80.6

June - P. Seine	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	4,081	15,255	7,468	1,512	245	78	4	2	-	-	28,643
% numbers	0%	14%	53%	26%	5%	1%	0%	0%	0%	0%	0%	100%
Catch wt. (t)	-	115	1,274	1,050	301	60	22	1	1	-	-	2,823
% catch wt.	0%	4%	45%	37%	11%	2%	1%	0%	0%	0%	0%	100%
Avg. len (cm)	-	16.4	22.6	26.5	29.3	31.1	32.2	33.5	35.0	-		23.2
Avg. wt. (g)	-	28.1	83.5	140.6	199.1	244.0	275.3	314.3	365.5	-		98.6

July - P. Seine	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	51	53,612	51,505	4,991	364	93	9	-	-	-	110,624
% numbers	0%	0%	48%	47%	5%	0%	0%	0%	0%	0%	0%	100%
Catch wt. (t)	-	2	5,277	7,385	965	87	26	3	-	-	-	13,745
% catch wt.	0%	0%	38%	54%	7%	1%	0%	0%	0%	0%	0%	100%
Avg. len (cm)	-	19.2	23.6	26.4	28.9	30.8	32.1	33.0	-	-		25.2
Avg. wt. (g)	-	48.7	98.4	143.4	193.4	239.8	276.9	302.4	-	-		124.2

Aug - P. Seine	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	484	17,887	42,330	4,617	648	84	2	-	-	-	66,051
% numbers	0%	1%	27%	64%	7%	1%	0%	0%	0%	0%	0%	100%
Catch wt. (t)	-	20	1,857	6,009	893	150	22	0	-	-	-	8,952
% catch wt.	0%	0%	21%	67%	10%	2%	0%	0%	0%	0%	0%	1.0
Avg. len (cm)	-	18.1	24.0	26.4	29.1	30.7	32.0	33.0	-	-		25.9
Avg. wt. (g)	-	41.7	103.8	142.0	193.4	232.0	263.3	292.3	-	-		135.5

Sept - P. Seine	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	15,494	14,582	43,493	8,718	1,530	520	21	-	-	-	84,359
% numbers	0%	18%	17%	52%	10%	2%	1%	0%	0%	0%	0%	100%
Catch wt. (t)	-	620	1,434	6,238	1,705	357	137	7	-	-	-	10,498
% catch wt.	0%	6%	14%	59%	16%	3%	1%	0%	0%	0%	0%	100%
Avg. len (cm)	-	18.0	23.6	26.6	29.2	30.8	32.0	33.8	-	-		24.9
Avg. wt. (g)	-	40.0	98.4	143.4	195.5	233.5	263.2	317.3	-	-		124.4

Oct - P. Seine	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	135	32,194	12,551	15,118	5,300	1,044	147	5	-	-	-	66,494
% numbers	0%	48%	19%	23%	8%	2%	0%	0%	0%	0%	0%	100%
Catch wt. (t)	3	1,274	1,257	2,195	1,019	239	37	1	-	-	-	6,024
% catch wt.	0%	21%	21%	36%	17%	4%	1%	0%	0%	0%	0%	100%
Avg. len (cm)	14.4	18.0	23.9	26.8	29.3	30.9	31.8	33.0	-	-		22.2
Avg. wt. (g)	19.2	39.6	100.1	145.2	192.2	229.0	252.0	284.5	-	-		90.6

Table 17. Herring catch at age by fishing ground for the 2005 summer purse seine fishery conducted on the SW Nova Scotia/Bay of Fundy spawning component (4WX stock).

Fishing Ground	Data Type	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Total
Gannet,Dry Ledge	Numbers (x1,000)	-	469	12,640	11,619	1,658	169	38	-	-	-	26,593
German Bank	Numbers (x1,000)	-	2,480	19,859	58,701	13,499	2,425	644	33	-	-	97,641
Grand Manan	Numbers (x1,000)	-	32	34,551	15,410	1,480	113	22	-	-	-	51,608
Long Island	Numbers (x1,000)	92	54,542	37,996	15,438	1,749	397	165	11	-	-	110,391
Lurcher	Numbers (x1,000)	-	902	2,706	8,385	1,540	127	87	1	1	-	13,748
NB Coastal	Numbers (x1,000)	46	644	470	219	21	-	-	-	-	-	1,400
Scots Bay	Numbers (x1,000)	-	3	10,215	29,246	3,968	649	125	-	-	-	44,206
Seal Island	Numbers (x1,000)	-	-	2,582	6,331	545	18	4	-	-	-	9,480
SW Grounds	Numbers (x1,000)	-	12	4,143	5,326	282	11	3	-	-	-	9,777
Trinity Ledge	Numbers (x1,000)	-	-	1,651	7,497	705	18	3	-	-	-	9,874
Yankee Bank	Numbers (x1,000)	-	-	1,752	2,376	74	11	17	-	-	-	4,230
Gannet,Dry Ledge	Catch wt. (t)	-	23	1,130	1,656	322	40	10	-	-	-	3,181
German Bank	Catch wt. (t)	-	121	2,128	8,560	2,614	564	167	10	-	-	14,164
Grand Manan	Catch wt. (t)	-	2	3,253	2,117	291	27	6	-	-	-	5,696
Long Island	Catch wt. (t)	2	2,095	3,076	2,089	345	94	44	3	-	-	7,728
Lurcher	Catch wt. (t)	-	38	258	1,229	295	30	23	0	0	-	1,874
NB Coastal	Catch wt. (t)	1	27	43	30	4	-	-	-	-	-	104
Scots Bay	Catch wt. (t)	-	0	1,175	4,101	779	151	34	-	-	-	6,239
Seal Island	Catch wt. (t)	-	-	284	916	104	4	1	-	-	-	1,310
SW Grounds	Catch wt. (t)	-	1	423	747	54	2	1	-	-	-	1,228
Trinity Ledge	Catch wt. (t)	-	-	190	1,111	132	4	1	-	-	-	1,438
Yankee Bank	Catch wt. (t)	-	-	182	322	14	3	4	-	-	-	525
Gannet,Dry Ledge	% catch wt.	0%	1%	36%	52%	10%	1%	0%	0%	0%	0%	100%
German Bank	% catch wt.	0%	1%	15%	60%	18%	4%	1%	0%	0%	0%	100%
Grand Manan	% catch wt.	0%	0%	57%	37%	5%	0%	0%	0%	0%	0%	100%
Long Island	% catch wt.	0%	27%	40%	27%	4%	1%	1%	0%	0%	0%	100%
Lurcher	% catch wt.	0%	2%	14%	66%	16%	2%	1%	0%	0%	0%	100%
NB Coastal	% catch wt.	1%	26%	41%	28%	4%	0%	0%	0%	0%	0%	100%
Scots Bay	% catch wt.	0%	0%	19%	66%	12%	2%	1%	0%	0%	0%	100%
Seal Island	% catch wt.	0%	0%	22%	70%	8%	0%	0%	0%	0%	0%	100%
SW Grounds	% catch wt.	0%	0%	34%	61%	4%	0%	0%	0%	0%	0%	100%
Trinity Ledge	% catch wt.	0%	0%	13%	77%	9%	0%	0%	0%	0%	0%	100%
Yankee Bank	% catch wt.	0%	0%	35%	61%	3%	1%	1%	0%	0%	0%	100%
Gannet,Dry Ledge	% numbers	0%	2%	48%	44%	6%	1%	0%	0%	0%	0%	100%
German Bank	% numbers	0%	3%	20%	60%	14%	2%	1%	0%	0%	0%	100%
Grand Manan	% numbers	0%	0%	67%	30%	3%	0%	0%	0%	0%	0%	100%
Long Island	% numbers	0%	49%	34%	14%	2%	0%	0%	0%	0%	0%	100%
Lurcher	% numbers	0%	7%	20%	61%	11%	1%	1%	0%	0%	0%	100%
NB Coastal	% numbers	3%	46%	34%	16%	2%	0%	0%	0%	0%	0%	100%
Scots Bay	% numbers	0%	0%	23%	66%	9%	1%	0%	0%	0%	0%	100%
Seal Island	% numbers	0%	0%	27%	67%	6%	0%	0%	0%	0%	0%	100%
SW Grounds	% numbers	0%	0%	42%	54%	3%	0%	0%	0%	0%	0%	100%
Trinity Ledge	% numbers	0%	0%	17%	76%	7%	0%	0%	0%	0%	0%	100%
Yankee Bank	% numbers	0%	0%	41%	56%	2%	0%	0%	0%	0%	0%	100%

Table 18. Catch at age (thousands) for the SW Nova Scotia / Bay of Fundy herring spawning component, 1965-2005.

Year	1	2	3	4	5	6	7	8	9	10	11+	Total
1965	270,378	1,084,719	34,835	234,383	49,925	10,592	1,693	561	54	37	1	1,687,178
1966	154,323	914,093	448,940	73,382	321,857	45,916	13,970	7,722	1,690	215	1	1,982,109
1967	722,208	613,970	153,626	266,454	110,051	159,203	57,948	4,497	409	296	148	2,088,810
1968	164,703	2,389,061	224,956	83,109	290,285	73,087	90,617	31,977	15,441	5,668	1,175	3,370,079
1969	108,875	290,329	531,812	132,319	162,439	112,631	62,506	22,595	6,345	2,693	722	1,433,266
1970	699,720	576,896	76,532	286,278	201,215	120,280	111,937	41,257	21,271	7,039	2,674	2,145,099
1971	87,570	404,224	183,896	106,630	113,566	75,593	93,620	50,022	36,618	7,536	5,695	1,164,970
1972		649,254	71,984	148,516	77,207	75,384	49,065	48,700	26,055	13,792	11,679	1,171,636
1973	1,018	167,454	781,061	130,851	40,128	30,334	22,046	20,249	23,871	11,630	13,386	1,242,028
1974	18,411	766,064	93,606	803,651	68,276	19,093	10,232	6,565	12,786	7,102	9,031	1,814,817
1975	3,199	317,641	239,827	124,599	514,605	66,302	12,298	4,409	4,778	3,847	6,225	1,297,730
1976	240	55,596	206,535	153,782	68,804	268,839	21,460	5,571	3,951	2,059	3,446	790,283
1977	1,170	153,921	31,572	218,478	119,234	51,173	177,247	13,977	3,170	1,415	3,894	775,251
1978	35,381	383,611	40,887	12,906	122,108	68,410	31,088	108,975	11,082	2,425	1,676	818,549
1979	342	183,982	250,393	54,620	5,430	23,142	18,255	11,836	41,389	4,527	2,411	596,327
1980	2,339	12,503	80,518	474,091	27,930	4,373	4,692	6,560	2,985	10,641	2,739	629,371
1981		103,051	50,883	102,743	451,482	32,978	2,418	2,767	1,917	538	2,149	750,926
1982	3,589	102,133	150,764	22,640	98,206	211,043	14,627	2,080	1,354	1,250	1,014	608,700
1983	5,488	191,682	150,328	244,007	24,483	60,678	89,982	10,352	1,728	642	1,324	780,694
1984		88,433	243,542	224,354	146,096	22,716	21,654	28,299	9,515	2,183	9,000	795,792
1985	9,022	216,740	337,591	302,782	147,670	42,404	14,075	18,178	7,997	1,201	470	1,098,130
1986	63	125,300	275,903	292,792	56,937	31,599	10,770	4,320	2,942	1,356	349	802,331
1987	2,300	82,940	126,436	527,443	242,597	45,933	19,481	7,292	3,361	3,120	650	1,061,553
1988	151	148,399	113,208	195,096	434,192	236,089	42,533	21,208	4,186	3,797	2,845	1,201,704
1989	8	101,788	114,095	61,842	79,451	169,023	76,684	18,303	8,270	3,814	3,057	636,335
1990		178,532	130,176	171,560	89,922	101,066	201,901	116,788	31,466	10,572	6,848	1,038,831
1991		96,960	179,463	183,647	88,431	41,352	50,380	80,732	45,516	18,291	13,524	798,296
1992	9	168,561	132,642	286,923	126,510	75,473	34,458	35,369	59,136	34,558	20,653	974,292
1993	166	76,405	43,766	194,198	130,713	67,708	33,820	21,481	21,893	20,684	11,175	622,009
1994	151	103,885	142,260	53,700	118,015	72,512	36,059	14,889	8,706	10,447	15,533	576,157
1995	1,831	113,457	219,777	112,245	36,784	36,402	22,127	6,474	4,217	2,957	3,566	559,837
1996		37,496	37,715	256,063	54,534	16,862	9,151	3,300	1,782	1,310	1,605	419,818
1997	356	56,561	87,395	78,098	131,062	18,917	5,131	3,636	894	620	874	383,544
1998	137	264,901	62,322	138,751	97,065	97,464	20,679	3,856	1,730	1,288	398	688,591
1999	2,694	112,893	223,283	147,840	131,463	57,291	10,044	613	212	70	13	686,415
2000	841	364,078	75,330	108,560	124,083	60,754	25,829	4,454	251	33	23	764,236
2001	51	73,368	325,273	57,175	60,409	31,891	15,509	2,203	304	8	4	566,193
2002	15,500	303,723	98,597	210,620	75,258	27,973	12,846	1,577	70	23	3	746,188
2003	459	486,345	342,592	114,850	96,847	13,111	7,136	435	23			1,061,798
2004	3,142	320,628	347,693	132,570	79,884	9,351	3,228	339	36	1		896,870
2005	135	72,039	171,155	180,893	28,030	4,286	1,050	49	2	2		457,640

Table 19. Catch at age (%) for the SW Nova Scotia / Bay of Fundy herring spawning component, 1965-2005.

Year	1	2	3	4	5	6	7	8	9	10	11+	Total
1965	16	64	2	14	3	1	0	0	0	0	0	100
1966	8	46	23	4	16	2	1	0	0	0	0	100
1967	35	29	7	13	5	8	3	0	0	0	0	100
1968	5	71	7	2	9	2	3	1	0	0	0	100
1969	8	20	37	9	11	8	4	2	0	0	0	100
1970	33	27	4	13	9	6	5	2	1	0	0	100
1971	8	35	16	9	10	6	8	4	3	1	0	100
1972	-	55	6	13	7	6	4	4	2	1	1	100
1973	0	13	63	11	3	2	2	2	2	1	1	100
1974	1	42	5	44	4	1	1	0	1	0	0	100
1975	0	24	18	10	40	5	1	0	0	0	0	100
1976	0	7	26	19	9	34	3	1	0	0	0	100
1977	0	20	4	28	15	7	23	2	0	0	1	100
1978	4	47	5	2	15	8	4	13	1	0	0	100
1979	0	31	42	9	1	4	3	2	7	1	0	100
1980	0	2	13	75	4	1	1	1	0	2	0	100
1981	-	14	7	14	60	4	0	0	0	0	0	100
1982	1	17	25	4	16	35	2	0	0	0	0	100
1983	1	25	19	31	3	8	12	1	0	0	0	100
1984	-	11	31	28	18	3	3	4	1	0	1	100
1985	1	20	31	28	13	4	1	2	1	0	0	100
1986	0	16	34	36	7	4	1	1	0	0	0	100
1987	0	8	12	50	23	4	2	1	0	0	0	100
1988	0	12	9	16	36	20	4	2	0	0	0	100
1989	0	16	18	10	12	27	12	3	1	1	0	100
1990	-	17	13	17	9	10	19	11	3	1	1	100
1991	-	12	22	23	11	5	6	10	6	2	2	100
1992	0	17	14	29	13	8	4	4	6	4	2	100
1993	0	12	7	31	21	11	5	3	4	3	2	100
1994	0	18	25	9	20	13	6	3	2	2	3	100
1995	0	20	39	20	7	7	4	1	1	1	1	100
1996	-	9	9	61	13	4	2	1	0	0	0	100
1997	0	15	23	20	34	5	1	1	0	0	0	100
1998	0	38	9	20	14	14	3	1	0	0	0	100
1999	0	16	33	22	19	8	1	0	0	0	0	100
2000	0	48	10	14	16	8	3	1	0	0	0	100
2001	0	13	57	10	11	6	3	0	0	0	0	100
2002	2	41	13	28	10	4	2	0	0	0	0	100
2003	0	46	32	11	9	1	1	0	0	-	-	100
2004	0	36	39	15	9	1	0	0	0	0	-	100
2005	0	16	37	40	6	1	0	0	0	0	-	100

Table 20. Average weights at age (g) for the SW Nova Scotia/Bay of Fundy component of the 4WX herring fishery (weighted by fishery) for 1965-2005 (values for 1979-83 are averages for the period 1968-78 as in Iles et al. 1984).

Year	Age 1	2	3	4	5	6	7	8	9	10
1965	10	41	112	172	218	254	286	323	354	389
1966	10	41	112	172	218	254	286	323	354	389
1967	10	41	112	172	218	254	286	323	354	389
1968	10	33	112	148	185	244	276	399	338	410
1969	10	37	105	162	207	242	282	306	334	390
1970	10	32	119	169	211	257	292	332	369	389
1971	10	66	143	199	230	254	293	329	362	388
1972	10	44	138	192	223	262	292	322	345	380
1973	10	29	106	143	225	252	279	331	360	389
1974	10	48	110	175	206	240	277	322	342	352
1975	10	21	94	179	216	240	268	333	358	379
1976	10	33	114	159	233	249	277	317	382	404
1977	10	65	113	174	214	274	293	325	328	416
1978	10	28	112	181	229	259	302	330	351	397
1979	10	41	112	172	218	254	286	323	354	389
1980	10	41	112	172	218	254	286	323	354	389
1981	10	41	112	172	218	254	286	323	354	389
1982	10	41	112	172	218	254	286	323	354	389
1983	10	41	112	172	218	254	286	323	354	389
1984	10	38	132	191	229	259	280	296	309	364
1985	10	53	118	204	249	278	315	334	344	440
1986	10	55	124	182	239	271	306	329	360	400
1987	12	50	98	153	199	245	274	290	318	350
1988	13	21	88	154	196	242	281	304	327	341
1989	7	33	79	162	207	238	274	303	324	353
1990	10	31	92	161	200	234	255	287	319	336
1991	10	48	100	147	186	217	251	270	303	322
1992	9	25	100	148	181	216	252	275	295	313
1993	18	29	108	153	188	215	251	279	302	324
1994	12	37	79	131	175	203	223	253	289	304
1995	15	42	76	136	187	223	247	293	300	326
1996	10	33	98	137	168	228	266	308	332	355
1997	19	34	80	161	190	238	284	314	358	376
1998	10	38	76	131	177	210	251	296	308	337
1999	20	42	75	120	172	220	263	304	344	378
2000	26	61	95	138	171	206	235	269	316	360
2001	22	58	108	150	190	227	268	293	327	370
2002	18	45	106	148	185	221	255	285	334	398
2003	21	42	85	149	182	225	259	294	316	
2004	11	35	87	139	190	230	261	300	344	333
2005	19	35	83	141	191	233	265	306	322	365

Table 21. Acoustic age composition for the overall SW Nova Scotia/Bay of Fundy component from 1999 to 2005.

Year and Area	Type Data	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
1999 Acoustics Overall	% catch wt.	0%	0%	13%	44%	32%	9%	0%	0%	0%	0%	100%
2000 Acoustics Overall	% catch wt.	2%	4%	21%	35%	23%	12%	2%	0%	0%	0%	100%
2001 Acoustics Overall	% catch wt.	1%	40%	15%	20%	14%	8%	2%	0%	0%	0%	100%
2002 Acoustics Overall	% catch wt.	1%	10%	53%	20%	9%	6%	1%	0%	0%	0%	100%
2003 Acoustics Overall	% catch wt.	1%	33%	28%	29%	5%	3%	0%	0%	0%	0%	100%
2004 Acoustics Overall	% catch wt.	0%	26%	35%	30%	6%	3%	0%	0%	0%	0%	100%
2005 Acoustics Overall	% catch wt.	0%	10%	61%	22%	5%	2%	0%	0%	0%	0%	100%
1999 Acoustics Overall	% numbers	0%	0%	18%	48%	27%	7%	0%	0%	0%	0%	100%
2000 Acoustics Overall	% numbers	6%	6%	25%	34%	18%	8%	1%	0%	0%	0%	100%
2001 Acoustics Overall	% numbers	3%	51%	15%	16%	9%	5%	1%	0%	0%	0%	100%
2002 Acoustics Overall	% numbers	2%	13%	57%	17%	6%	4%	1%	0%	0%	0%	100%
2003 Acoustics Overall	% numbers	4%	43%	26%	22%	3%	2%	0%	0%	0%	0%	100%
2004 Acoustics Overall	% numbers	1%	34%	37%	23%	4%	1%	0%	0%	0%	0%	100%
2005 Acoustics Overall	% numbers	0%	14%	64%	17%	3%	1%	0%	0%	0%	0%	100%
1999 Acoustics Overall	Avg. len (cm)	23.5	24.1	25.8	27.8	30.1	31.9	33.1	34.5	35.5		28.4
2000 Acoustics Overall	Avg. len (cm)	20.8	24.8	26.7	28.5	30.4	31.9	33.2	34.2	36.0		28.0
2001 Acoustics Overall	Avg. len (cm)	21.1	25.1	26.9	28.7	30.4	31.9	32.7	34.1	-		26.7
2002 Acoustics Overall	Avg. len (cm)	19.8	25.2	27.1	28.8	30.6	31.8	32.7	34.0	35.5		27.4
2003 Acoustics Overall	Avg. len (cm)	19.4	24.6	27.3	28.7	30.6	31.8	33.2	35.5	-		26.3
2004 Acoustics Overall	Avg. len (cm)	20.5	24.7	26.6	29.0	30.8	31.7	33.3	35.0	-		26.7
2005 Acoustics Overall	Avg. len (cm)	18.8	24.5	26.8	29.2	30.9	31.9	33.8	-	35.0		27.0
1999 Acoustics Overall	Avg. wt. (g)	104.5	113.2	140.7	176.4	226.9	272.4	304.6	349.2	383.2		190.8
2000 Acoustics Overall	Avg. wt. (g)	62.1	111.0	141.7	176.3	215.7	252.1	289.3	325.1	387.9		171.6
2001 Acoustics Overall	Avg. wt. (g)	66.7	121.0	153.5	191.1	229.3	269.8	293.8	331.2	-		154.5
2002 Acoustics Overall	Avg. wt. (g)	52.6	117.3	150.0	183.7	225.8	261.2	289.1	308.6	399.6		158.6
2003 Acoustics Overall	Avg. wt. (g)	52.0	109.8	155.3	184.4	226.8	257.9	295.4	375.0	-		142.2
2004 Acoustics Overall	Avg. wt. (g)	60.1	111.7	143.2	190.6	231.9	257.3	302.8	355.1	-		148.1
2005 Acoustics Overall	Avg. wt. (g)	46.0	109.1	146.8	195.2	233.5	260.4	315.5	-	365.5		153.8
1999 Acoustics Overall	Catch wt. (t)	2	1,340	65,702	222,154	164,425	47,128	1,759	2,321	360	488	505,680
2000 Acoustics Overall	Catch wt. (t)	9,970	18,896	97,401	164,048	107,143	53,938	10,782	656	68	401	463,309
2001 Acoustics Overall	Catch wt. (t)	5,816	181,463	70,313	89,288	64,184	38,563	7,473	721	-	-	457,820
2002 Acoustics Overall	Catch wt. (t)	4,268	53,164	290,700	108,883	49,212	31,696	5,019	247	154	-	543,401
2003 Acoustics Overall	Catch wt. (t)	7,078	167,908	143,848	146,842	23,783	15,357	615	0	-	-	505,432
2004 Acoustics Overall	Catch wt. (t)	1,542	123,285	170,922	144,816	27,229	12,172	991	807	-	-	481,764
2005 Acoustics Overall	Catch wt. (t)	170	23,261	141,935	51,677	11,840	4,084	199	-	2	-	233,168
1999 Acoustics Overall	Numbers (x1,000)	22	11,837	466,939	1,259,696	724,815	173,021	5,775	6,645	941	1,091	2,650,782
2000 Acoustics Overall	Numbers (x1,000)	160,418	170,220	687,340	930,573	496,803	213,924	37,273	2,019	175	1,000	2,699,924
2001 Acoustics Overall	Numbers (x1,000)	87,170	1,499,796	457,975	467,332	279,943	142,956	25,436	2,178	-	-	2,962,785
2002 Acoustics Overall	Numbers (x1,000)	81,122	453,103	1,938,353	592,580	217,955	121,346	17,362	799	385	-	3,425,381
2003 Acoustics Overall	Numbers (x1,000)	136,238	1,528,559	926,469	796,381	104,841	59,548	2,081	1	-	-	3,554,118
2004 Acoustics Overall	Numbers (x1,000)	25,675	1,103,423	1,193,644	759,611	117,403	47,312	3,275	2,271	-	-	3,252,614
2005 Acoustics Overall	Numbers (x1,000)	3,705	213,306	966,885	264,704	50,696	15,687	629	-	4	-	1,515,617

Table 22. Acoustic age composition for the German Bank only component from 1999 to 2005.

Year and Area	Type Data	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
1999 German Bank Acoustic	% catch wt.	0%	0%	13%	43%	33%	10%	0%	0%	0%	0%	100%
2000 German Bank Acoustic	% catch wt.	3%	5%	21%	37%	22%	11%	2%	0%	0%	0%	100%
2001 German Bank Acoustic	% catch wt.	3%	42%	15%	17%	13%	9%	2%	0%	0%	0%	100%
2002 German Bank Acoustic	% catch wt.	1%	10%	52%	20%	10%	6%	1%	0%	0%	0%	100%
2003 German Bank Acoustic	% catch wt.	2%	38%	26%	27%	5%	3%	0%	0%	0%	0%	100%
2004 German Bank Acoustic	% catch wt.	0%	24%	37%	29%	6%	3%	0%	0%	0%	0%	100%
2005 German Bank Acoustic	% catch wt.	0%	9%	61%	23%	5%	2%	0%	0%	0%	0%	100%
1999 German Bank Acoustic	% numbers	0%	0%	18%	47%	28%	7%	0%	0%	0%	0%	100%
2000 German Bank Acoustic	% numbers	8%	7%	25%	35%	17%	7%	1%	0%	0%	0%	100%
2001 German Bank Acoustic	% numbers	6%	52%	14%	13%	9%	5%	1%	0%	0%	0%	100%
2002 German Bank Acoustic	% numbers	3%	13%	55%	18%	7%	4%	1%	0%	0%	0%	100%
2003 German Bank Acoustic	% numbers	5%	47%	24%	20%	3%	1%	0%	0%	0%	0%	100%
2004 German Bank Acoustic	% numbers	1%	32%	39%	23%	4%	1%	0%	0%	0%	0%	100%
2005 German Bank Acoustic	% numbers	0%	13%	64%	18%	3%	1%	0%	0%	0%	0%	100%
1999 German Bank Acoustic	Avg. len (cm)	-	24.3	25.9	27.8	30.1	31.9	33.1	34.5	35.5		28.4
2000 German Bank Acoustic	Avg. len (cm)	20.8	24.7	26.7	28.6	30.5	32.1	33.4	34.3	36.0		27.9
2001 German Bank Acoustic	Avg. len (cm)	20.9	24.9	26.9	28.8	30.4	31.9	32.7	34.2	-		26.3
2002 German Bank Acoustic	Avg. len (cm)	19.8	25.1	27.1	28.8	30.6	31.8	32.7	34.0	35.5		27.3
2003 German Bank Acoustic	Avg. len (cm)	19.4	24.6	27.2	28.8	30.6	31.8	33.2	-	-		26.1
2004 German Bank Acoustic	Avg. len (cm)	20.5	24.7	26.6	28.9	30.8	31.7	33.4	35.0	-		26.7
2005 German Bank Acoustic	Avg. len (cm)	18.8	24.4	26.8	29.2	30.9	31.9	33.8	-	-		27.1
1999 German Bank Acoustic	Avg. wt. (g)	-	115.5	140.8	175.9	227.0	273.0	304.3	349.2	383.2		191.0
2000 German Bank Acoustic	Avg. wt. (g)	62.1	109.8	141.1	176.2	215.1	253.5	292.2	325.8	387.9		168.3
2001 German Bank Acoustic	Avg. wt. (g)	65.0	116.2	150.4	188.2	226.3	263.9	290.5	330.2	-		145.2
2002 German Bank Acoustic	Avg. wt. (g)	52.4	114.8	149.4	182.4	224.6	260.9	288.3	308.7	399.7		157.3
2003 German Bank Acoustic	Avg. wt. (g)	51.6	110.5	153.2	184.3	225.3	257.7	294.4	-	-		138.1
2004 German Bank Acoustic	Avg. wt. (g)	59.7	111.2	142.4	188.7	231.3	254.4	304.1	355.1	-		147.9
2005 German Bank Acoustic	Avg. wt. (g)	46.0	108.4	147.2	194.8	233.4	259.5	315.4	-	-		154.5
1999 German Bank Acoustic	Catch wt. (t)	-	1,147	60,304	199,056	150,905	44,574	1,692	2,304	358	483	460,823
2000 German Bank Acoustic	Catch wt. (t)	9,925	16,104	73,991	130,516	77,649	39,509	7,673	531	68	400	356,372
2001 German Bank Acoustic	Catch wt. (t)	5,539	79,728	27,881	31,435	25,436	16,294	3,602	579	-	-	190,494
2002 German Bank Acoustic	Catch wt. (t)	4,126	38,440	204,661	80,340	37,487	23,712	3,909	234	152	-	393,121
2003 German Bank Acoustic	Catch wt. (t)	6,149	129,474	90,497	91,212	16,202	9,448	505	-	-	-	343,486
2004 German Bank Acoustic	Catch wt. (t)	1,344	87,359	137,786	107,750	22,383	9,414	786	807	-	-	367,629
2005 German Bank Acoustic	Catch wt. (t)	160	19,812	128,673	47,501	10,851	3,773	188	-	-	-	210,959
1999 German Bank Acoustic	Numbers (x1,000)	-	9,924	428,280	1,131,660	664,725	163,298	5,561	6,599	934	1,079	2,412,061
2000 German Bank Acoustic	Numbers (x1,000)	159,866	146,724	524,346	740,919	360,915	155,853	26,263	1,631	175	996	2,117,866
2001 German Bank Acoustic	Numbers (x1,000)	85,238	685,939	185,393	167,059	112,396	61,752	12,400	1,753	-	-	1,311,930
2002 German Bank Acoustic	Numbers (x1,000)	78,824	334,785	1,370,159	440,402	166,919	90,875	13,560	758	380	-	2,499,028
2003 German Bank Acoustic	Numbers (x1,000)	119,130	1,172,040	590,615	494,790	71,925	36,656	1,717	-	-	-	2,486,873
2004 German Bank Acoustic	Numbers (x1,000)	22,502	785,706	967,910	571,000	96,778	37,007	2,586	2,271	-	-	2,485,760
2005 German Bank Acoustic	Numbers (x1,000)	3,489	182,737	874,175	243,815	46,493	14,539	597	-	-	-	1,365,846

Table 23. Exploitation pattern at age for 1990 to 2005 and various periods from the initial VPA calculated based on mean population weighted F for ages 6 to 8. The 2005 values represents the assumptions used in the terminal year of the VPA.

PR using F(6-8wt'd)	1	2	3	4	5	6	7	8	9	10	11
1990	0.0	0.3	0.4	0.8	0.8	0.8	1.1	1.0	0.7	1.0	0.6
1991	0.0	0.3	0.5	1.0	0.9	0.8	0.9	1.2	1.0	1.0	1.5
1992	0.0	0.8	0.4	1.0	1.0	1.1	0.9	0.9	1.3	1.1	1.1
1993	0.0	0.2	0.3	0.8	0.9	1.0	1.0	1.0	1.0	1.0	0.4
1994	0.0	0.1	0.3	0.4	0.9	1.0	1.2	0.9	0.8	1.0	0.4
1995	0.0	0.2	0.2	0.5	0.6	0.9	1.2	0.8	0.8	1.0	0.1
1996	0.0	0.1	0.1	0.7	0.8	1.0	1.0	0.8	0.9	1.0	0.1
1997	0.0	0.1	0.3	0.4	1.1	0.9	1.2	1.6	0.7	1.0	0.1
1998	0.0	0.2	0.1	0.2	0.3	0.9	1.5	1.3	1.3	1.0	0.0
1999	0.0	0.3	0.6	0.5	0.9	1.0	1.0	1.1	1.7	1.0	0.0
2000	0.0	0.2	0.2	0.4	0.7	0.8	1.4	1.5	1.8	1.0	0.0
2001	0.0	0.1	0.4	0.3	0.6	0.8	1.5	1.7	1.6	1.0	0.0
2002	0.0	0.2	0.2	0.5	0.8	0.7	1.6	2.0	0.3	1.0	0.0
2003	0.0	0.2	0.5	0.4	1.1	0.8	1.5	1.2	1.2	0.0	0.0
2004	0.0	0.2	0.3	0.6	1.1	0.8	1.6	2.0	1.1	0.3	0.0
2005	0.0	0.2	0.4	0.7	0.9	1.0	1.0	1.0	1.0	1.0	0.0
Avg 1965-1974	0.3	1.4	0.6	0.9	1.1	1.0	1.1	1.0	1.4	1.0	1.5
Avg 1975-1984	0.0	0.3	0.4	0.7	0.9	0.9	0.9	1.1	1.3	1.0	1.5
Avg 1985-1994	0.0	0.4	0.5	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.6
Avg 1995-2004	0.0	0.2	0.3	0.5	0.8	0.9	1.4	1.4	1.1	0.8	0.0
Avg last 5yr (2000-04)	0.0	0.2	0.3	0.4	0.9	0.8	1.5	1.7	1.2	0.7	0.0
Avg all years (65-04)	0.1	0.6	0.5	0.7	1.0	0.9	1.1	1.1	1.2	1.0	0.9

Table 24. Beginning of year population abundance (numbers 000's) from ADAPT run using the overall acoustic index (ages 4-8) as proportional to population numbers.

Pop #s Bias Adj(analytical)	1	2	3	4	5	6	7	8	9	10	11	Total PopNos '000s	SSB PopNos '000s	Total Biomass t	SSB t
1965	3,503,534	3,848,688	995,990	1,312,007	348,049	92,556	44,658	4,104	1,354	406	500	10,151,846	2,170,428	448,078	300,889
1966	2,737,874	2,624,572	2,177,169	784,001	863,223	239,988	66,231	35,035	2,855	1,060	707	9,532,714	3,003,285	576,761	425,447
1967	6,078,739	2,102,325	1,329,624	1,378,701	575,717	418,512	155,171	41,661	21,740	836	1,253	12,104,280	3,120,533	630,063	489,845
1968	1,286,168	4,325,977	1,170,158	950,142	889,042	372,334	200,109	75,150	30,056	17,430	1,311	9,317,877	3,025,639	626,797	489,645
1969	1,754,254	904,620	1,415,817	755,635	702,962	467,578	239,085	82,892	32,938	10,845	9,244	6,375,870	2,933,524	540,430	461,373
1970	2,304,087	1,338,027	480,252	682,955	499,558	429,512	281,595	139,599	47,575	21,258	13,377	6,237,795	2,287,259	493,215	435,280
1971	7,460,417	1,258,574	579,796	324,285	303,152	228,973	243,661	130,382	77,266	19,947	19,640	10,646,092	1,604,775	418,839	326,339
1972	1,138,007	6,028,985	667,899	309,749	169,889	146,502	119,687	115,682	61,966	30,575	20,551	8,809,493	1,277,576	427,933	257,782
1973	2,336,523	931,722	4,350,854	481,941	121,063	70,132	52,761	54,102	51,165	27,434	19,153	8,496,850	3,004,984	498,727	316,858
1974	1,625,829	1,912,063	612,115	2,859,195	277,069	63,139	30,305	23,481	26,162	20,577	15,921	7,465,858	3,335,988	576,167	466,828
1975	247,148	1,314,489	880,008	416,859	1,619,372	165,491	34,561	15,639	13,330	10,013	15,485	4,732,396	2,689,070	516,875	461,061
1976	721,820	199,458	790,742	505,119	229,479	864,256	76,167	17,278	8,846	6,633	11,863	3,431,662	2,064,500	389,059	357,084
1977	4,140,081	590,760	113,384	461,878	275,572	126,138	466,414	43,093	9,149	3,712	10,203	6,240,385	1,406,665	341,890	292,120
1978	1,346,539	3,388,555	345,406	64,483	183,136	119,041	57,492	223,170	22,748	4,650	6,640	5,761,860	847,615	264,317	185,307
1979	449,147	1,070,504	2,428,553	245,946	41,184	41,880	36,645	19,392	85,497	8,737	5,577	4,433,065	1,674,539	262,852	167,544
1980	1,572,597	367,422	710,839	1,762,596	152,252	28,826	13,695	13,722	5,372	33,069	5,530	4,665,920	2,194,223	368,282	304,527
1981	1,669,558	1,285,420	289,532	509,412	1,017,308	99,518	19,663	7,007	5,380	1,742	19,616	4,924,156	1,773,471	362,179	311,026
1982	2,302,838	1,366,918	959,467	191,249	324,646	429,491	51,910	13,919	3,261	2,687	15,067	5,661,453	1,492,838	320,454	246,240
1983	4,078,526	1,882,162	1,027,010	649,785	136,177	177,675	163,382	29,368	9,523	1,459	12,505	8,167,572	1,628,400	348,357	245,507
1984	5,027,282	3,334,258	1,368,174	705,445	313,499	89,457	91,079	53,687	14,768	6,242	9,665	11,013,555	1,897,384	424,424	276,947
1985	1,831,381	4,115,990	2,650,014	900,962	376,337	126,231	52,832	55,107	18,746	3,661	3,339	10,134,600	2,772,125	582,291	376,214
1986	1,059,694	1,491,259	3,174,295	1,865,457	466,203	175,953	65,334	30,614	28,818	8,199	4,231	8,370,056	4,045,410	762,585	566,868
1987	1,397,308	867,547	1,107,935	2,350,078	1,263,651	330,385	115,618	43,794	21,173	20,942	8,641	7,527,073	4,473,242	819,446	714,331
1988	1,401,917	1,141,942	635,504	793,142	1,449,860	816,306	229,118	77,122	29,291	14,308	20,824	6,609,334	3,668,409	702,333	641,945
1989	1,744,614	1,147,656	801,233	418,412	474,051	797,404	456,413	149,310	44,098	20,211	22,791	6,076,194	2,741,466	558,575	507,688
1990	1,185,719	1,428,362	847,830	553,220	286,868	316,593	500,847	304,643	105,751	28,662	29,020	5,587,516	2,494,198	517,598	461,548
1991	579,910	970,785	1,008,567	576,914	299,026	154,203	168,557	229,416	144,866	58,343	31,602	4,222,188	2,109,518	404,647	344,924
1992	824,078	474,790	707,394	664,216	307,618	165,457	89,111	92,791	115,487	77,777	45,143	3,563,861	1,844,874	340,460	296,235
1993	1,669,807	674,690	237,693	459,804	287,340	138,696	68,056	42,113	44,305	41,843	51,315	3,715,661	1,206,337	244,961	201,234
1994	877,050	1,366,972	483,523	155,220	202,812	118,503	53,150	25,557	15,331	16,747	47,773	3,362,639	861,333	180,827	126,506
1995	1,031,470	717,932	1,025,476	268,195	78,955	61,164	32,668	11,627	7,693	4,810	29,629	3,269,618	980,658	156,145	99,626
1996	913,346	842,843	485,628	641,941	119,202	31,801	17,745	7,177	3,759	2,545	22,358	3,088,345	1,025,147	160,550	114,716
1997	1,190,194	747,785	656,218	363,580	296,445	48,890	11,017	6,373	2,929	1,487	17,773	3,342,691	1,040,245	179,192	127,988
1998	619,421	974,127	561,215	458,527	227,441	125,595	23,094	4,439	1,984	1,596	14,426	3,011,864	1,091,857	181,261	133,106
1999	1,700,724	507,015	559,656	403,309	250,907	99,434	17,222	1,005	282	121	11,630	3,551,305	1,023,406	163,985	115,311
2000	695,211	1,390,002	313,603	258,409	197,780	88,303	30,480	5,174	279	44	9,547	2,988,831	720,976	163,627	90,187
2001	1,320,249	568,431	810,998	189,053	114,490	51,890	18,599	2,432	359	11	7,803	3,084,316	771,232	167,955	89,698
2002	1,827,341	1,080,882	399,285	372,946	103,480	39,925	14,185	1,682	88	29	6,387	3,846,230	701,069	165,906	89,721
2003	1,109,406	1,482,101	612,261	238,308	118,014	18,374	7,983	515	26	11	5,230	3,592,228	670,759	153,543	72,844
2004	419,699	907,890	777,340	196,503	92,625	11,913	3,474	357	42	1	4,291	2,414,134	678,225	115,745	63,123
2005	1,000,000	340,782	456,017	325,797	43,619	6,314	1,547	72	3	3	3,513	2,177,666	576,296	96,293	54,780
2006	1,000,000	818,609	214,219	220,091	105,786	10,874	1,379	338	16	1	2,877	2,374,189	426,461	91,734	48,646

Table 25. Fishing mortality rate from ADAPT run using the overall acoustic index (ages 4-8) as proportional to population numbers.

F Bias Adj(analytical)	1	2	3	4	5	6	7	8	9	10	11	F5-7(wtd)	F5-8(wtd)	F6-8(wtd)
1965	0.09	0.37	0.04	0.22	0.17	0.13	0.04	0.16	0.04	0.11	0.00	0.15	0.15	0.11
1966	0.06	0.48	0.26	0.11	0.52	0.24	0.26	0.28	1.03	0.25	0.00	0.45	0.45	0.25
1967	0.14	0.39	0.14	0.24	0.24	0.54	0.53	0.13	0.02	0.49	0.14	0.38	0.38	0.51
1968	0.15	0.92	0.24	0.10	0.44	0.24	0.68	0.62	0.82	0.44	2.94	0.42	0.43	0.42
1969	0.07	0.43	0.53	0.21	0.29	0.31	0.34	0.36	0.24	0.32	0.09	0.31	0.31	0.32
1970	0.40	0.64	0.19	0.61	0.58	0.37	0.57	0.39	0.67	0.45	0.25	0.50	0.49	0.44
1971	0.01	0.43	0.43	0.45	0.53	0.45	0.54	0.54	0.73	0.53	0.38	0.51	0.51	0.51
1972	0.00	0.13	0.13	0.74	0.68	0.82	0.59	0.62	0.61	0.68	0.96	0.71	0.69	0.69
1973	0.00	0.22	0.22	0.35	0.45	0.64	0.61	0.53	0.71	0.62	1.40	0.54	0.54	0.60
1974	0.01	0.58	0.18	0.37	0.32	0.40	0.46	0.37	0.76	0.47	0.96	0.34	0.34	0.41
1975	0.01	0.31	0.36	0.40	0.43	0.58	0.49	0.37	0.50	0.54	0.58	0.44	0.44	0.55
1976	0.00	0.36	0.34	0.41	0.40	0.42	0.37	0.44	0.67	0.42	0.38	0.41	0.41	0.41
1977	0.00	0.34	0.36	0.73	0.64	0.59	0.54	0.44	0.48	0.54	0.54	0.58	0.57	0.54
1978	0.03	0.13	0.14	0.25	1.28	0.98	0.89	0.76	0.76	0.84	0.32	1.11	0.98	0.84
1979	0.00	0.21	0.12	0.28	0.16	0.92	0.78	1.08	0.75	0.83	0.64	0.61	0.68	0.90
1980	0.00	0.04	0.13	0.35	0.23	0.18	0.47	0.74	0.93	0.43	0.78	0.24	0.27	0.39
1981	0.00	0.09	0.21	0.25	0.66	0.45	0.15	0.57	0.49	0.41	0.13	0.63	0.63	0.41
1982	0.00	0.09	0.19	0.14	0.40	0.77	0.37	0.18	0.60	0.71	0.08	0.59	0.59	0.71
1983	0.00	0.12	0.18	0.53	0.22	0.47	0.91	0.49	0.22	0.65	0.12	0.55	0.55	0.67
1984	0.00	0.03	0.22	0.43	0.71	0.33	0.30	0.85	1.19	0.48	3.75	0.57	0.59	0.44
1985	0.01	0.06	0.15	0.46	0.56	0.46	0.35	0.45	0.63	0.45	0.17	0.52	0.51	0.43
1986	0.00	0.10	0.10	0.19	0.14	0.22	0.20	0.17	0.12	0.20	0.10	0.17	0.17	0.21
1987	0.00	0.11	0.13	0.28	0.24	0.17	0.20	0.20	0.19	0.18	0.09	0.22	0.22	0.18
1988	0.00	0.15	0.22	0.31	0.40	0.38	0.23	0.36	0.17	0.34	0.16	0.38	0.38	0.35
1989	0.00	0.10	0.17	0.18	0.20	0.27	0.20	0.14	0.23	0.23	0.16	0.23	0.23	0.23
1990	0.00	0.15	0.18	0.42	0.42	0.43	0.58	0.54	0.39	0.52	0.30	0.50	0.51	0.53
1991	0.00	0.12	0.22	0.43	0.39	0.35	0.40	0.49	0.42	0.42	0.63	0.38	0.41	0.42
1992	0.00	0.49	0.23	0.64	0.60	0.69	0.55	0.54	0.82	0.66	0.69	0.62	0.61	0.61
1993	0.00	0.13	0.23	0.62	0.69	0.76	0.78	0.81	0.77	0.77	0.27	0.72	0.73	0.77
1994	0.00	0.09	0.39	0.48	1.00	1.09	1.32	1.00	0.96	1.13	0.44	1.07	1.07	1.14
1995	0.00	0.19	0.27	0.61	0.71	1.04	1.32	0.93	0.91	1.10	0.14	0.94	0.94	1.11
1996	0.00	0.05	0.09	0.57	0.69	0.86	0.82	0.70	0.73	0.82	0.08	0.74	0.74	0.83
1997	0.00	0.09	0.16	0.27	0.66	0.55	0.71	0.97	0.41	0.61	0.06	0.65	0.65	0.62
1998	0.00	0.35	0.13	0.40	0.63	1.79	2.93	2.56	2.60	1.99	0.03	1.16	1.17	1.98
1999	0.00	0.28	0.57	0.51	0.84	0.98	1.00	1.08	1.66	0.99	0.00	0.89	0.89	0.99
2000	0.00	0.34	0.31	0.61	1.14	1.36	2.33	2.47	3.01	1.65	0.00	1.31	1.33	1.64
2001	0.00	0.15	0.58	0.40	0.85	1.10	2.20	3.12	2.32	1.45	0.00	1.06	1.08	1.45
2002	0.01	0.37	0.32	0.95	1.53	1.41	3.12	3.98	1.92	1.92	0.00	1.64	1.67	1.92
2003	0.00	0.45	0.94	0.74	2.09	1.47	2.91	2.31	2.88	0.00	0.00	2.06	2.06	1.91
2004	0.01	0.49	0.67	1.31	2.49	1.84	3.67	4.60	2.45	2.31	0.00	2.45	2.46	2.31
2005	0.00	0.26	0.53	0.92	1.19	1.32	1.32	1.32	1.32	1.32	0	1.21	1.21	1.32

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Table 26. Deterministic projection inputs for SW Nova Scotia/Bay of Fundy spawning component .

	F level	Exp rate u	1/u
F0.1	0.228	0.185	5.3913
test F	0.210	0.172	5.8046
Fmax	0.568	0.396	2.5223

	F level	Exp rate u	1/u
F0.1	0.228	0.185	5.3913
test F	0.200	0.165	6.0665
Fmax	0.568	0.396	2.5223

F0.1 and Fmax from 2004 run in YPR_2004.xls
-using PR for 1993-2002, wts for 1965-2003, mat=50% 3's, 100% 4+

Inputs below are version with correct wts at age for 2006-2007

M	1	2	3	4	5	6	7	8	9	10	11
2006	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
PR	1	2	3	4	5	6	7	8	9	10	11
2006	0	0.2	0.4	0.7	0.9	1	1	1	1	1	1
Beg wt	1	2	3	4	5	6	7	8	9	10	11
2006	0.019046	0.019356	0.053801	0.110614	0.16285	0.210236	0.246411	0.2826449	0.310813	0.354306	0.354306
2007	0.019046	0.019356	0.053801	0.110614	0.16285	0.210236	0.246411	0.2826449	0.310813	0.354306	0.354306
Avg wt	1	2	3	4	5	6	7	8	9	10	11
2006	0.0192	0.034733	0.083257	0.140896	0.191433	0.23252	0.264503	0.3061911	0.321934	0.364893	0.364893
Maturity	1	2	3	4	5	6	7	8	9	10	11
2006	0	0	0.5	0.9	1	1	1	1	1	1	1
2007	0	0	0.5	0.9	1	1	1	1	1	1	1

Table 27. Beginning of year population abundance (numbers 000's) from ADAPT run using the German Bank only index (ages 4-8) as proportional to population numbers.

Pop #s Bias Adj(analytical)	1	2	3	4	5	6	7	8	9	10	11	Total PopNos '000s	SSB PopNos '000s	Total Biomass t	SSB t
1965	3,503,534	3,848,688	995,990	1,312,007	348,049	92,556	44,658	4,104	1,354	406	500	10,151,846	2,170,428	448,078	300,889
1966	2,737,874	2,624,572	2,177,169	784,001	863,223	239,988	66,231	35,035	2,855	1,060	707	9,532,714	3,003,285	576,761	425,447
1967	6,078,739	2,102,325	1,329,624	1,378,701	575,717	418,512	155,171	41,661	21,740	836	1,253	12,104,280	3,120,533	630,063	489,845
1968	1,286,168	4,325,977	1,170,158	950,142	889,042	372,334	200,109	75,150	30,056	17,430	1,311	9,317,877	3,025,639	626,797	489,645
1969	1,754,254	904,620	1,415,817	755,635	702,962	467,578	239,085	82,892	32,938	10,845	9,244	6,375,870	2,933,524	540,430	461,373
1970	2,304,087	1,338,027	480,252	682,955	499,558	429,512	281,595	139,599	47,575	21,258	13,377	6,237,795	2,287,259	493,215	435,280
1971	7,460,417	1,258,574	579,796	324,285	303,152	228,973	243,661	130,382	77,266	19,947	19,640	10,646,092	1,604,775	418,839	326,339
1972	1,138,007	6,028,985	667,899	309,749	169,889	146,502	119,687	115,682	61,966	30,575	20,551	8,809,493	1,277,576	427,933	257,782
1973	2,336,523	931,722	4,350,854	481,941	121,063	70,132	52,761	54,102	51,165	27,434	19,153	8,496,850	3,004,984	498,727	316,858
1974	1,625,829	1,912,063	612,115	2,859,195	277,069	63,139	30,305	23,481	26,162	20,577	15,921	7,465,858	3,335,988	576,167	466,828
1975	247,148	1,314,489	880,008	416,859	1,619,372	165,491	34,561	15,639	13,330	10,013	15,485	4,732,396	2,689,070	516,875	461,061
1976	721,820	199,458	790,742	505,119	229,479	864,256	76,167	17,278	8,846	6,633	11,863	3,431,662	2,064,500	389,059	357,084
1977	4,140,081	590,760	113,384	461,878	275,572	126,138	466,414	43,093	9,149	3,712	10,203	6,240,385	1,406,665	341,890	292,120
1978	1,346,539	3,388,555	345,406	64,483	183,136	119,041	57,492	223,170	22,748	4,650	6,640	5,761,860	847,615	264,317	185,307
1979	449,147	1,070,508	2,428,553	245,946	41,184	41,880	36,645	19,392	85,497	8,737	5,577	4,433,065	1,674,539	262,852	167,544
1980	1,572,597	367,422	710,839	1,762,596	152,252	28,826	13,695	13,722	5,372	33,069	5,530	4,665,920	2,194,223	368,282	304,527
1981	1,669,558	1,285,420	289,532	509,412	1,017,308	99,518	19,663	7,007	5,380	1,742	19,616	4,924,156	1,773,471	362,179	311,026
1982	2,302,838	1,366,918	959,467	191,249	324,646	429,491	51,910	13,919	3,261	2,687	15,067	5,661,453	1,492,838	320,454	246,240
1983	4,078,526	1,882,162	1,027,010	649,785	136,177	177,675	163,382	29,368	9,523	1,459	12,505	8,167,572	1,628,400	348,357	245,507
1984	5,027,282	3,334,258	1,368,174	705,445	313,499	89,457	91,079	53,687	14,768	6,242	9,665	11,013,555	1,897,384	424,424	276,947
1985	1,831,381	4,115,990	2,650,014	900,962	376,337	126,231	52,832	55,107	18,746	3,661	3,339	10,134,600	2,772,125	582,291	376,214
1986	1,059,694	1,491,259	3,174,295	1,865,457	466,203	175,953	65,334	30,614	28,818	8,199	4,231	8,370,056	4,045,410	762,585	566,868
1987	1,397,308	867,547	1,107,935	2,350,078	1,263,651	330,385	115,618	43,794	21,173	20,942	8,641	7,527,073	4,473,242	819,446	714,331
1988	1,401,917	1,141,942	635,504	793,142	1,449,860	816,306	229,118	77,122	29,291	14,308	20,824	6,609,334	3,668,409	702,333	641,945
1989	1,744,614	1,147,656	801,233	418,412	474,051	797,404	456,413	149,310	44,098	20,211	22,791	6,076,194	2,741,466	558,575	507,688
1990	1,185,719	1,428,362	847,830	553,220	286,868	316,593	500,847	304,643	105,751	28,662	29,020	5,587,516	2,494,198	517,598	461,548
1991	579,910	970,785	1,008,567	576,914	299,026	154,203	168,557	229,416	144,866	58,343	31,602	4,222,188	2,109,518	404,647	344,924
1992	824,078	474,790	707,394	664,216	307,618	165,457	89,111	92,791	115,487	77,777	45,143	3,563,861	1,844,874	340,460	296,235
1993	1,669,807	674,690	237,693	459,804	287,340	138,696	68,056	42,113	44,305	41,843	51,315	3,715,661	1,206,337	244,961	201,234
1994	877,050	1,366,972	483,523	155,220	202,812	118,503	53,150	25,557	15,331	16,747	47,773	3,362,639	861,333	180,827	126,506
1995	1,031,471	717,932	1,025,476	268,195	78,955	61,164	32,668	11,627	7,693	4,810	29,629	3,269,618	980,658	156,145	99,626
1996	913,353	842,843	485,628	641,941	119,202	31,801	17,745	7,177	3,759	2,545	22,358	3,088,351	1,025,147	160,550	114,716
1997	1,190,201	747,790	656,218	363,580	296,445	48,890	11,017	6,373	2,929	1,487	17,773	3,342,703	1,040,246	179,192	127,988
1998	619,517	974,132	561,219	458,527	227,441	125,595	23,094	4,439	1,964	1,596	14,426	3,011,971	1,091,859	181,262	133,106
1999	1,702,100	507,094	559,661	403,312	250,907	99,434	17,222	1,005	282	121	11,630	3,552,768	1,023,412	164,003	115,312
2000	699,645	1,391,128	313,667	258,412	197,783	88,303	30,480	5,174	279	44	9,547	2,994,463	721,015	163,751	90,190
2001	1,345,106	572,061	811,919	189,106	114,493	51,893	18,599	2,432	359	11	7,803	3,113,782	771,745	168,573	89,742
2002	1,995,355	1,101,234	402,256	373,696	103,522	39,928	14,187	1,682	88	29	6,387	4,038,363	703,277	168,872	89,931
2003	1,342,461	1,619,659	628,886	240,736	118,619	18,408	7,985	516	26	11	5,230	3,982,536	681,899	162,528	73,738
2004	581,550	1,098,699	889,632	209,925	94,595	12,372	3,500	358	43	1	4,291	2,894,966	748,909	130,543	68,270
2005	1,000,000	473,295	611,752	417,166	54,332	7,765	1,902	89	4	4	3,513	2,569,821	748,934	119,486	70,208
2006	1,000,000	818,609	322,624	347,187	179,860	19,503	2,543	623	29	1	2,877	2,693,857	679,217	125,874	78,464

Table 28. Fishing mortality rate from ADAPT run using the German Bank only acoustic index (ages 4-8) as proportional to population numbers.

F Bias Adj(analytical)	1	2	3	4	5	6	7	8	9	10	11	F5-7(wtd)	F5-8(wtd)	F6-8(wtd)
1965	0.09	0.37	0.04	0.22	0.17	0 13	0.04	0.16	0.04	0.11	0.00	0.15	0.15	0.11
1966	0.06	0.48	0.26	0.11	0.52	0.24	0.26	0.28	1.03	0.25	0.00	0.45	0.45	0.25
1967	0.14	0.39	0.14	0.24	0.24	0.54	0.53	0.13	0.02	0.49	0.14	0.38	0.38	0.51
1968	0.15	0.92	0.24	0.10	0.44	0.24	0.68	0.62	0.82	0.44	2.94	0.42	0.43	0.42
1969	0.07	0.43	0.53	0.21	0.29	0.31	0.34	0.36	0.24	0.32	0 09	0.31	0.31	0.32
1970	0.40	0.64	0.19	0.61	0.58	0.37	0.57	0.39	0.67	0.45	0.25	0.50	0.49	0.44
1971	0 01	0.43	0.43	0.45	0.53	0.45	0.54	0.54	0.73	0.53	0.38	0.51	0.51	0.51
1972	0.00	0.13	0.13	0.74	0.68	0.82	0.59	0.62	0.61	0.68	0.96	0.71	0.69	0.69
1973	0.00	0.22	0.22	0.35	0.45	0.64	0.61	0.53	0.71	0.62	1.40	0.54	0.54	0.60
1974	0.01	0.58	0.18	0.37	0.32	0 40	0.46	0.37	0.76	0.47	0.96	0.34	0.34	0.41
1975	0.01	0.31	0.36	0.40	0.43	0 58	0.49	0.37	0.50	0.54	0.58	0.44	0.44	0.55
1976	0.00	0.36	0.34	0.41	0.40	0.42	0.37	0.44	0.67	0.42	0.38	0.41	0.41	0.41
1977	0.00	0.34	0.36	0.73	0.64	0.59	0.54	0.44	0.48	0.54	0.54	0.58	0.57	0.54
1978	0.03	0.13	0.14	0.25	1.28	0.98	0.89	0.76	0.76	0.84	0.32	1.11	0.98	0.84
1979	0.00	0.21	0.12	0.28	0.16	0.92	0.78	1.08	0.75	0.83	0.64	0 61	0.68	0.90
1980	0.00	0.04	0.13	0.35	0.23	0.18	0.47	0.74	0.93	0.43	0 78	0.24	0.27	0.39
1981	0.00	0.09	0.21	0.25	0.66	0.45	0.15	0.57	0.49	0.41	0.13	0.63	0.63	0.41
1982	0.00	0.09	0.19	0.14	0.40	0.77	0.37	0.18	0.60	0.71	0.08	0.59	0.59	0.71
1983	0.00	0.12	0.18	0.53	0.22	0.47	0.91	0.49	0.22	0.65	0.12	0.55	0.55	0.67
1984	0.00	0.03	0.22	0.43	0.71	0.33	0.30	0.85	1.19	0.48	3.75	0.57	0.59	0.44
1985	0.01	0.06	0.15	0.46	0.56	0.46	0.35	0.45	0.63	0.45	0.17	0.52	0.51	0.43
1986	0.00	0.10	0 10	0.19	0 14	0.22	0.20	0.17	0 12	0.20	0.10	0.17	0.17	0.21
1987	0.00	0.11	0 13	0.28	0.24	0.17	0.20	0.20	0.19	0.18	0.09	0.22	0.22	0.18
1988	0.00	0.15	0.22	0.31	0.40	0.38	0.23	0.36	0.17	0.34	0.16	0.38	0.38	0.35
1989	0.00	0.10	0.17	0.18	0.20	0 27	0.20	0.14	0.23	0.23	0.16	0.23	0.23	0.23
1990	0.00	0.15	0.18	0.42	0.42	0.43	0.58	0.54	0.39	0.52	0.30	0.50	0.51	0.53
1991	0.00	0.12	0.22	0.43	0.39	0.35	0.40	0.49	0.42	0.42	0.63	0.38	0.41	0.42
1992	0.00	0.49	0.23	0.64	0.60	0.69	0.55	0.54	0.82	0.66	0 69	0.62	0.61	0.61
1993	0.00	0.13	0.23	0.62	0.69	0.76	0.78	0.81	0.77	0.77	0.27	0.72	0.73	0.77
1994	0.00	0.09	0.39	0.48	1.00	1.09	1.32	1.00	0.96	1.13	0.44	1.07	1.07	1.14
1995	0.00	0.19	0.27	0.61	0.71	1.04	1.32	0.93	0.91	1.10	0.14	0.94	0.94	1.11
1996	0.00	0.05	0.09	0.57	0.69	0.86	0.82	0.70	0.73	0.82	0.08	0.74	0.74	0.83
1997	0.00	0.09	0.16	0.27	0.66	0.55	0.71	0.97	0.41	0.61	0.06	0.65	0.65	0.62
1998	0.00	0.35	0.13	0.40	0.63	1.79	2.93	2.56	2.60	1.99	0.03	1.16	1.17	1.98
1999	0.00	0.28	0.57	0.51	0.84	0.98	1.00	1.08	1.66	0.99	0.00	0.89	0.89	0.99
2000	0.00	0.34	0.31	0.61	1.14	1.36	2.33	2.47	3.01	1.65	0.00	1.31	1.33	1.64
2001	0.00	0.15	0.58	0.40	0.85	1.10	2.20	3.12	2.32	1.45	0 00	1.06	1.08	1.45
2002	0.01	0.36	0.31	0 95	1.53	1.41	3.11	3 98	1.92	1.92	0 00	1.64	1.66	1.92
2003	0.00	0.40	0.90	0.73	2.06	1.46	2.90	2.29	2 86	0.00	0.00	2.03	2.03	1.90
2004	0.01	0.39	0.56	1.15	2.30	1 67	3.47	4.39	2.27	2.12	0.00	2.27	2.27	2.12
2005	0.00	0.18	0.37	0.64	0.82	0.92	0.92	0.92	0.92	0.92	0	0.84	0.84	0.92

Table 29. An evaluation of 2003-2005 fishery observations for the SW Nova Scotia/Bay of Fundy spawning component progress against biological objectives in the management plan for the fishery.

	Objective	2003: Met	2003: Not Met	2004: Observations	2005: Observations
1	**Maintain reproductive capacity**				
1a	Persistence of all spawning components	German Bank and Scots Bay OK; Trinity recovering	Limited signs of Seal Island component Increased fishing on juveniles of mixed origin inconsistent with this objective	Trinity reduced from 2003; no reports from Seal or Lurcher areas	Trinity Ledge remains at a low level; no reports of spawning in Seal Island or Lurcher Shoal areas
1b	Maintain biomass of each component	German Bank and Scots Bay	Trinity Ledge and Seal Island	No change	German Bank and Scots Bay have declining biomass estimates. Trinity Ledge, Lurcher Shoal and Seal Island are at low biomass. Substantial decline in the acoustic index from 2004.
1c	Maintain broad age composition		Not met in all areas Few fish older than age 7; only 20% 4+. Rapid decline of year-classes (including strong 1998 year-class)	Further decline in proportion of older ages	Further decline in proportion of older ages. Age composition is very narrow. Targeting of small fish was reduced in 2005.
1d	Maintain long spawning period	German Bank and Scots Bay	Trinity and Seal Island	Longer period for Scots	Delayed start and shorter duration of spawning in 2005 for both Scots Bay and German Bank.
2	**Prevent growth over-fishing**				
2a	Fishing mortality at or below F0.1	Landings in recent years less than 20% of surveyed SSB	High total mortality and targeting of 2 year olds	High exploitation rate for Scots Bay. May be higher than F0.1 if survey SSB is overestimated.	Fishing mortality is high and well above $F_{0.1}$.
3	**Maintain ecosystem integrity / ecological relationships**				
3a	Maintain spatial and temporal diversity of spawning	German Bank and Scots Bay	Insufficient spawning at Seal Island and Trinity Ledge	No change.	Insufficient spawning in some areas.
3b	Maintain biomass at moderate to high levels	Acoustic surveys indicate moderate SSB		Apparently no change but discrepancy with VPA results	SSB is at lowest recorded level.

Table 30. 2005 4WX offshore herring fisheries catch at age in number (thousands) and weight (t).

a - Offshore Banks Purse Seine

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	-	814	8,872	10,777	1,965	593	44	22	10	-	23,098
% numbers	0%	0%	4%	38%	47%	9%	3%	0%	0%	0%	0%	100%
Catch wt. (t)	-	-	92	1,389	2,157	479	160	14	7	4	-	4,303
% catch wt.	0%	0%	2%	32%	50%	11%	4%	0%	0%	0%	0%	100%
Avg. len (cm)	-	-	24.9	27.4	29.4	31.2	32.1	33.5	34.1	35.0		28.7 Avg. Len
Avg. wt. (g)	-	-	113.5	156.6	200.2	243.6	270.5	314.3	334.5	365.5		186.3 Avg. wt

b - Offshore Midwater Trawl

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	-	258	3,030	2,212	357	80	-	3	-	-	5,940
% numbers	0%	0%	4%	51%	37%	6%	1%	0%	0%	0%	0%	100%
Catch wt. (t)	-	-	28	409	361	69	17	-	1	-	-	885
% catch wt.	0%	0%	3%	46%	41%	8%	2%	0%	0%	0%	0%	100%
Avg. len (cm)	-	-	25.4	27.4	29.2	31.0	31.9	-	33.5	-		28.3 Avg. Len
Avg. wt. (g)	-	-	108.8	135.1	163.2	193.4	209.3	-	241.0	-		149.0 Avg. wt

c - 4WX Bottom Trawl & Misc. Gear Catches

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	1	185	188	171	83	28	11	2	0	0	-	669
% numbers	0%	28%	28%	26%	12%	4%	2%	0%	0%	0%	0%	100%
Catch wt. (t)	0	7	16	25	16	7	3	1	0	0	-	75
% catch wt.	0%	9%	22%	33%	22%	9%	4%	1%	0%	0%	0%	100%
Avg. len (cm)	13.9	17.7	22.8	26.7	29.4	31.1	32.2	33.1	33.7	35.0		23.7 Avg. Len
Avg. wt. (g)	17.2	37.7	87.7	144.9	199.0	238.0	264.6	288.8	310.9	365.5		112.1 Avg. wt

Table 31. Herring larval abundance index from autumn Bay of Fundy plankton survey (average number of larvae per m^2 to bottom from 79 fixed location index stations).

Year	Cruise	Larval Herring Bongo Survey No. per m2 to bottom Mean	SE	N
1972	P109	9.4	1.8	79
1973	P127	6.6	1.3	79
1974	P147	49.5	10.9	79
1975	P160	11.7	1.5	58
1976	P175	13.5	2.9	79
1977	P190	6.3	1.0	79
1978	P207	4.5	0.5	77
1979	P232	7.1	2.1	79
1980	P246	26.2	6.7	79
1981	P263	2.7	0.3	78
1982	P280	10.6	1.2	77
1983	P298	13.9	1.6	74
1984	P315	12.7	1.4	78
1985	P329	40.8	4.6	79
1986	P344	18.9	2.1	78
1987	P361	27.9	3.2	78
1988	P377	100.7	11.5	76
1989	P391	54.5	6.1	79
1990	P408	27.2	3.1	79
1991	P422	48.2	5.5	78
1992	P437	57.0	6.4	79
1993	P451	55.0	6.2	78
1994	N211	5.4	0.7	77
1995	N232	20.3	4.6	78
1996	N252	9.5	1.6	77
1997	N765	23.3	2.7	77
1998	N865	33.6	3.8	77

There has been no larval survey since 1999.

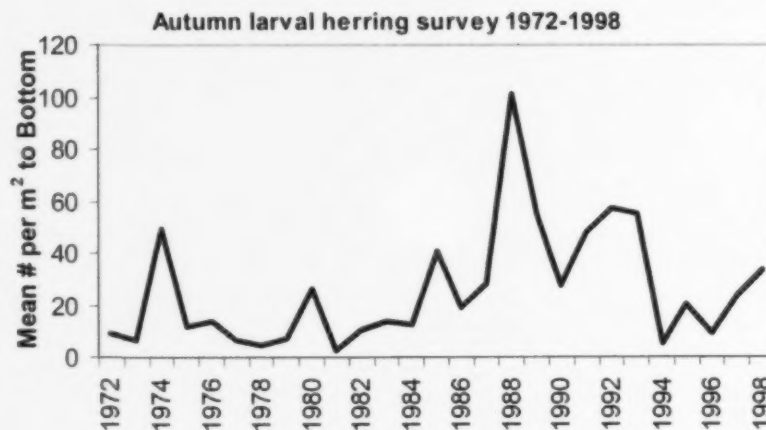Autumn larval herring survey 1972-1998

Table 32. Herring abundance indices from the July bottom trawl survey (stratified numbers per tow): 1970-2005.

		July ground trawl survey by-catch for herring (stratified mean numbers)												
		4WX area combined strata 453/495			4W Only strata 453/466		4X Only strata 470/495		4X BOF strata 480/495		4V only strata 442/452		Offshore Banks strata 455/478	
Year	Cruise	Mean#	SE	N	Mean#	SE	Mean#	SE	Mean#	SE	Mean#	SE	Mean#	SE
1970	A175/176	4.1	1.5	95	4.9	2.4	1.6	0.6	1.0	0.6	12.8	9.8	5.7	2.4
1971	A188/189	4.0	1.9	86	2.6	1.2	3.6	2.6	1.4	1.0	4.4	4.4	5.3	2.8
1972	A200/201	1.4	0.6	105	1.7	1.0	0.5	0.1	0.3	0.1	4.5	3.7	2.0	1.0
1973	A212/213	0.9	0.3	96	0.4	0.3	1.0	0.4	1.0	0.4	19.2	19.2	0.9	0.4
1974	A225/226	0.7	0.3	102	0.2	0.0	1.0	0.4	1.4	0.6	0.0	0.0	0.5	0.2
1975	A236/237	0.9	0.4	104	0.8	0.4	0.7	0.4	1.3	0.7	2.2	2.2	0.7	0.4
1976	A250/251	0.4	0.2	103	0.1	0.1	0.5	0.3	0.9	0.6	0.0	0.0	0.1	0.1
1977	A265/266	0.5	0.3	106	0.0	0.0	0.8	0.5	1.5	0.9	1.6	1.4	0.1	0.1
1978	A279/280	0.3	0.3	103	0.5	0.5	0.1	0.0	0.1	0.0	0.0	0.0	0.5	0.5
1979	A292/293	0.6	0.5	106	0.0	0.0	1.0	0.7	1.5	1.3	0.0	0.0	0.2	0.2
1980	A306/307	0.5	0.5	105	0.0	0.0	0.8	0.8	1.6	1.6	0.0	0.0	0.0	0.0
1981	A321/322	1.5	1.4	104	0.0	0.0	2.3	2.1	4.6	4.1	0.0	0.0	0.0	0.0
1982	H080/081	1.5	0.9	108	0.5	0.3	1.9	1.4	0.8	0.3	0.0	0.0	2.5	1.7
1983	N012/013	2.4	0.8	106	2.6	1.2	2.2	1.0	3.1	1.6	0.1	0.0	2.1	1.0
1984	N031/032	7.0	3.5	102	3.3	1.2	10.5	6.8	4.6	2.5	4.0	2.9	8.5	5.4
1985	N048/049	3.4	1.8	111	6.6	3.8	0.3	0.1	0.4	0.2	0.0	0.0	5.0	2.9
1986	N065/066	23.2	14.9	118	30.8	26.7	16.0	14.3	24.9	22.3	0.5	0.4	23.4	20.3
1987	N85/86/87	10.4	5.6	135	17.0	11.3	4.0	1.8	6.3	2.8	117.4	90.5	12.9	8.6
1988	N105/106	2.1	0.6	127	2.7	1.2	1.5	0.5	2.3	0.8	0.3	0.2	2.0	0.9
1989	N123/124	8.4	1.8	124	11.8	3.4	4.5	1.2	4.9	1.4	3.6	3.1	9.8	2.7
1990	N139/140	5.6	1.9	156	7.4	3.6	3.4	1.0	3.4	0.8	0.3	0.2	6.5	2.9
1991	N154/H231	10.6	5.8	137	13.0	8.8	5.0	1.8	4.9	2.3	10.2	9.9	14.3	9.0
1992	N173/174	16.5	4.9	136	16.2	6.6	40.8	15.7	41.8	22.2	0.2	0.1	23.6	7.4
1993	N189/190	18.7	4.5	137	6.3	2.5	30.4	8.5	27.6	10.3	1.0	0.6	15.0	4.7
1994	N221/222	76.4	30.2	140	108.4	58.9	45.9	18.4	51.1	26.0	25.7	22.0	91.1	45.1
1995	N226/227	63.5	24.2	140	100.5	47.9	28.4	12.8	11.4	5.4	7.9	6.1	92.7	37.6
1996	N246/247	40.2	14.2	135	53.2	24.5	27.1	14.1	32.1	20.8	0.2	0.1	46.5	19.5
1997	N726/734	31.8	15.3	137	34.6	10.1	51.3	39.3	72.8	60.9	0.2	0.1	29.3	7.7
1998	N827/832	99.52	20.65	131	147.6	39.92	54.76	14.5	45.6	19.4	0.8	0.3	130.3	30.3
1999	N925/929	229.8	83.8	133	264.2	101.0	199.4	130.2	251.4	203.6	24.9	15.2	226.2	74.4
2000	N426/431	90.6	20.0	146	146.3	40.6	38.7	7.4	29.5	9.1	2.0	0.6	124.7	30.5
2001	N2001-032/037	145.9	47.7	139	152.7	81.3	139.5	52.5	181.3	80.9	53.9	49.2	132.4	60.9
2002	N2002-037/040	161.9	48.6	147	172.7	81.3	151.9	55.6	170.9	85.3	4.9	2.6	162.6	61.1
2003	N2003-036/042	130.6	70.5	153	207.8	145.4	58.7	14.5	50.3	14.0	4.9	2.0	175.8	108.6
2004t	TEL2004-529/530	295.9	100.2	205	307.6	134.5	285.0	147.4	198.0	170.9	1.4	0.4	355.6	127.6
2005t	TEL2005-605/633	74.1	13.7	118	13.7	8.7	130.5	23.1	51.8	34.4	7.4	2.2	88.0	6.6
2005n	NED2005-027/034	63.1	20.9	150	36.0	13.1	88.2	38.5	61.0	30.2	13.6	5.4	66.2	28.4

Table 33. Stratified mean numbers per tow by age of herring for NAFO unit areas 4WX (strata 53/95) from the DFO July bottom trawl research survey, 1970-2005.

Year	1	2	3	4	5	6	7	8	9	10	11+	Unkown	TOTAL
1970			0.1	1.6	1.2	0.8	0.2	0.1	0.0				4.0
1971			0.4	0.8	1.3	0.7	0.5	0.0	0.0	0.0	0.0	0.1	3.9
1972		0.1	0.0	0.2	0.3	0.4	0.2	0.1	0.0	0.0	0.0	0.1	1.4
1973			0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.0	0.0	0.1	0.9
1974		0.0	0.1	0.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8
1975		0.0	0.1	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.1		0.9
1976		0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0		0.4
1977		0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0			0.3	0.5
1978	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0		0.4
1979		0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.6
1980	0.0	0.0	0.0	0.0	0.0	0.0						0.5	0.5
1981	0.1	0.1	0.4	0.7	0.2	0.0	0.0	0.0	0.0	0.0		0.0	1.5
1982		0.1	0.3	0.3	0.7	0.4	0.0	0.0	0.0	0.0	0.0	0.0	1.9
1983	0.0	0.6	0.2	0.6	0.1	0.3	0.3	0.1	0.0	0.0	0.0	0.0	2.4
1984	0.0	0.1	0.4	0.8	1.2	0.3	0.3	0.3	0.0	0.1	3.5	0.0	7.0
1985		0.1	0.2	1.1	1.0	0.6	0.2	0.2	0.1	0.0	0.0	0.0	3.4
1986		0.2	7.2	7.2	4.7	2.4	1.1	0.2	0.1	0.1	0.1	0.0	23.4
1987	0.0	1.0	3.7	2.7	1.1	0.8	0.4	0.3	0.2	0.1	0.1		10.4
1988		0.3	0.1	0.4	0.7	0.4	0.1	0.0	0.0	0.0	0.0	0.0	2.1
1989	0.2	0.2	0.4	0.8	1.0	2.9	1.7	0.3	0.1	0.1	0.1	0.1	8.0
1990	0.1	0.2	0.6	0.8	0.7	0.7	1.3	0.7	0.1	0.0	0.1	0.0	5.3
1991		0.1	0.5	1.6	1.9	1.1	1.6	2.7	0.9	0.2	0.1	0.0	10.9
1992		11.6	1.3	1.8	2.8	4.1	2.1	1.9	2.6	0.6	0.3	0.1	29.1
1993		0.1	0.8	3.1	4.2	4.1	3.1	1.3	0.9	0.8	0.4		18.8
1994		0.1	5.1	9.5	23.2	18.4	7.0	0.5	1.4	3.4	1.2	6.1	75.9
1995	0.0	0.5	10.7	13.1	9.4	13.8	9.2	3.3	1.6	1.0	1.3	0.1	63.9
1996	0.0	0.3	1.8	19.1	7.9	5.3	3.2	1.1	0.3	0.2	0.2	0.0	39.4
1997	1.2	20.0	1.8	5.7	9.1	2.0	1.2	0.6	0.2	0.1	0.3	0.9	43.2
1998	0.1	1.5	2.4	22.0	37.8	28.4	5.2	1.4	0.4	0.2	0.2	0.0	99.5
1999	0.2	7.3	59.5	32.6	92.9	29.8	2.3	0.1	0.0	0.0		0.1	224.7
2000	0.1	1.2	9.1	31.7	30.8	13.2	4.0	0.4	0.0	0.0		0.0	90.6
2001		5.3	95.0	14.1	22.7	7.2	1.3	0.1	0.0			0.0	145.8
2002	1.8	34.9	41.8	56.9	18.4	5.1	2.4	0.4	0.0	0.0		0.2	161.9
2003	0.2	4.5	23.5	56.8	37.5	5.5	1.9	0.0				0.7	130.6
2004	47.5	2.2	64.3	99.7	69.5	4.1	2.6	0.2	0.0			5.9	295.9
2005		0.2	17.7	34.0	9.7	0.6	0.2	0.0				0.7	63.0

Table 34. Recorded landings (t) of herring from gillnet fisheries on the Coastal Nova Scotia Spawning component, 1996-2005.

Landings (t)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Avg. Catch Last 5 yr.	Avg. Catch All Years
Little Hope/Port Mouton		490	1,170	2,919	2,043	2,904	3,982	4,526	1,267	2,239	2,827	2,393
Halifax/Eastern Shore	1,280	1,520	1,100	1,628	1,350	1,898	3,334	2,727	4,176	3,446	2,822	2,246
Glace Bay		170	1,730	1,040	834	1,204	3,058	1,905	1,481	626	1,518	1,339
Bras d'Or Lakes'	170	160	120	31	56	0	1	4			15	68
Total	1,450	2,340	4,120	5,618	4,283	6,006	10,375	9,162	6,924	6,311	7,177	5,659

'Bras d'Or Lakes fishery closed in 2004

Table 35. Summary of the estimated spawning biomass of herring from gillnet fisheries in the Coastal Nova Scotia Spawning component from 1998-2005. Total SSB is rounded to nearest 100t.

Survey SSB (t) without CIF	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	10% SSB Last 5 yr.	10% SSB All Years
Little Hope/Port Mouton			14,100	15,800	5,200	21,300	56,000	63,700	15,600	39,500	3,355	2,890
Halifax/Eastern Shore			8,300	20,200	10,900	16,700	41,500	77,400	18,200	28,100	3,213	2,766
Glace Bay				2,000		21,200	7,700	31,500		2,200	1,565	1,292
Bras d'Or Lakes				530	70						7	30

Table 36. Summary of the exploitation of herring from major gillnet fisheries in the Coastal Nova Scotia Spawning component from 1998-2005. Exploitation is calculated percent landings / SSB.

Exploitation (% Landings/SSB)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Average % Last 5 yr.	Average % All Years
Little Hope/Port Mouton			8%	18%	39%	14%	7%	7%	8%	6%	13%	13%
Halifax/Eastern Shore			13%	8%	12%	11%	8%	4%	23%	12%	12%	11%
Glace Bay				52%		6%	40%	6%		28%	20%	26%
Bras d'Or Lakes				6%	80%						80%	43%

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Table 37. Catch at age for herring from the coastal Nova Scotia fisheries in 2005.

4X Little Hope/Port Mouton Gillnet

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	-	10	1,316	5,062	3,027	926	138	64	-	-	10,545
% numbers	0%	0%	0%	12%	48%	29%	9%	1%	1%	0%	0%	100%
Catch wt. (t)	-	-	1	219	1,011	709	239	40	19	-	-	2,239
% catch wt.	0%	0%	0%	10%	45%	32%	11%	2%	1%	0%	0%	100%
Avg. len (cm)	-	-	26.0	28.0	29.6	31.1	32.0	33.2	33.5	-		30.1
Avg. wt. (g)	-	-	130.2	166.7	199.6	234.3	258.1	290.6	298.8	-		212.3

4W Halifax/Eastern Shore Gillnet

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	-	1	591	5,521	4,928	3,330	506	13	-	-	14,891
% numbers	0%	0%	0%	4%	37%	33%	22%	3%	0%	0%	0%	100%
Catch wt. (t)	-	-	0	100	1,136	1,176	885	145	5	-	-	3,446
% catch wt.	0%	0%	0%	3%	33%	34%	26%	4%	0%	0%	0%	100%
Avg. len (cm)	-	-	26.0	28.0	29.8	31.2	32.2	33.1	35.0	-		30.9
Avg. wt. (g)	-	-	132.7	168.7	205.7	238.5	265.7	287.3	354.8	-		231.4

4Vn Gillnet Glace Bay

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	-	-	17	402	859	995	136	34	-	-	2,443
% numbers	0%	0%	0%	1%	16%	35%	41%	6%	1%	0%	0%	100%
Catch wt. (t)	-	-	-	3	89	210	268	43	12	-	-	626
% catch wt.	0%	0%	0%	0%	14%	34%	43%	7%	2%	0%	0%	100%
Avg. len (cm)	-	-	-	27.0	30.4	31.3	32.2	33.8	35.3	-		31.7
Avg. wt. (g)	-	-	-	150.4	222.8	244.8	269.6	316.6	363.4	-		256.3

Table 38. New Brunswick weir and shutoff catch at age for herring in 2005.

NB Weir and Shutoff combined for 2005
Catch at age (numbers and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	1,117	102,227	76,137	21,310	1,182	63	7	-	-	-	-	202,044
% numbers	1%	51%	38%	11%	1%	0%	0%	0%	0%	0%	0%	100%
Catch wt. (t)	22	3,898	6,090	2,805	223	15	2	-	-	-	-	13,055
% catch wt.	0%	30%	47%	21%	2%	0%	0%	0%	0%	0%	0%	100%
Avg. len (cm)	14.0	17.7	22.1	25.8	28.9	30.7	31.8	-	-	-		20.2
Avg. wt. (g)	19.3	38.1	80.0	131.6	188.5	229.9	259.1	-	-	-		64.6

NB Weirs (only) for 2005
Catch at age (numbers and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	372	94,460	75,008	21,175	1,170	63	7	-	-	-	-	192,257
% numbers	0%	49%	39%	11%	1%	0%	0%	0%	0%	0%	0%	100%
Catch wt. (t)	7	3,594	6,013	2,789	221	15	2	-	-	-	-	12,640
% catch wt.	0%	28%	48%	22%	2%	0%	0%	0%	0%	0%	0%	100%
Avg. len (cm)	13.8	17.6	22.1	25.8	28.9	30.7	31.8	-	-	-		20.4
Avg. wt. (g)	17.7	38.1	80.2	131.7	188.6	229.9	259.1	-	-	-		65.7

NB Shutoff (only) for 2005
Catch at age (numbers and weight)

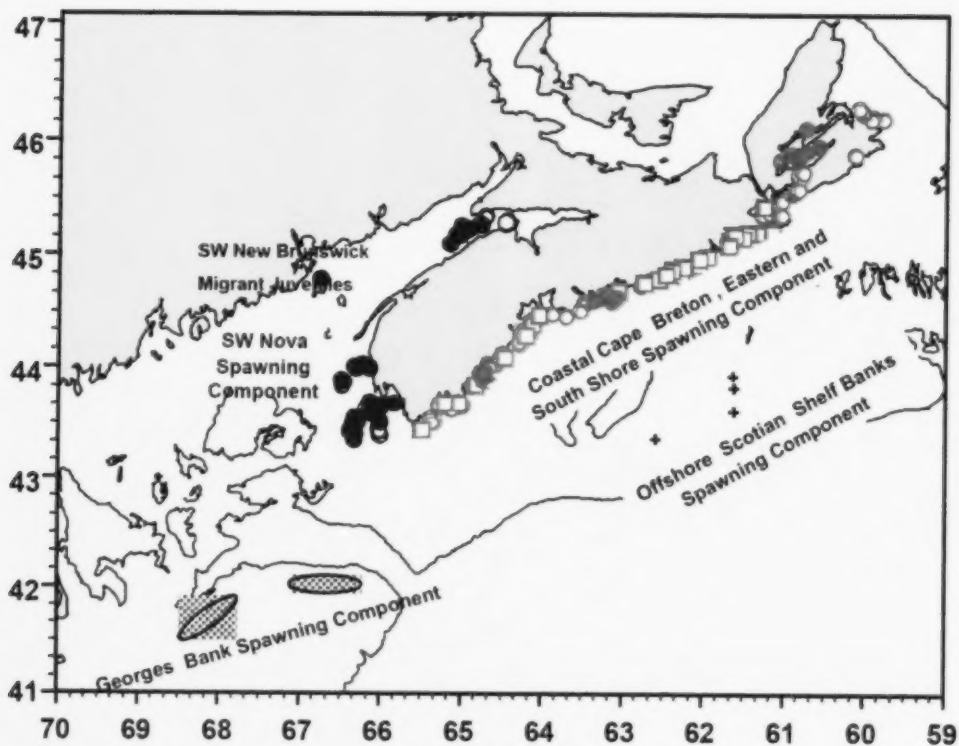|	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	745	7,766	1,129	135	12	-	-	-	-	-	-	9,787
% numbers	8%	79%	12%	1%	0%	0%	0%	0%	0%	0%	0%	100%
Catch wt. (t)	15	304	77	17	2	-	-	-	-	-	-	415
% catch wt.	4%	73%	19%	4%	1%	0%	0%	0%	0%	0%	0%	100%
Avg. len (cm)	14.1	17.8	21.1	25.4	28.8	-	-	-	-	-		18.0
Avg. wt. (g)	20.0	39.2	68.3	123.3	187.2	-	-	-	-	-		42.4

Figure 1. Management units for herring in areas 4VWX and 5YZ showing locations of known current (solid) and historical (open) spawning locations.
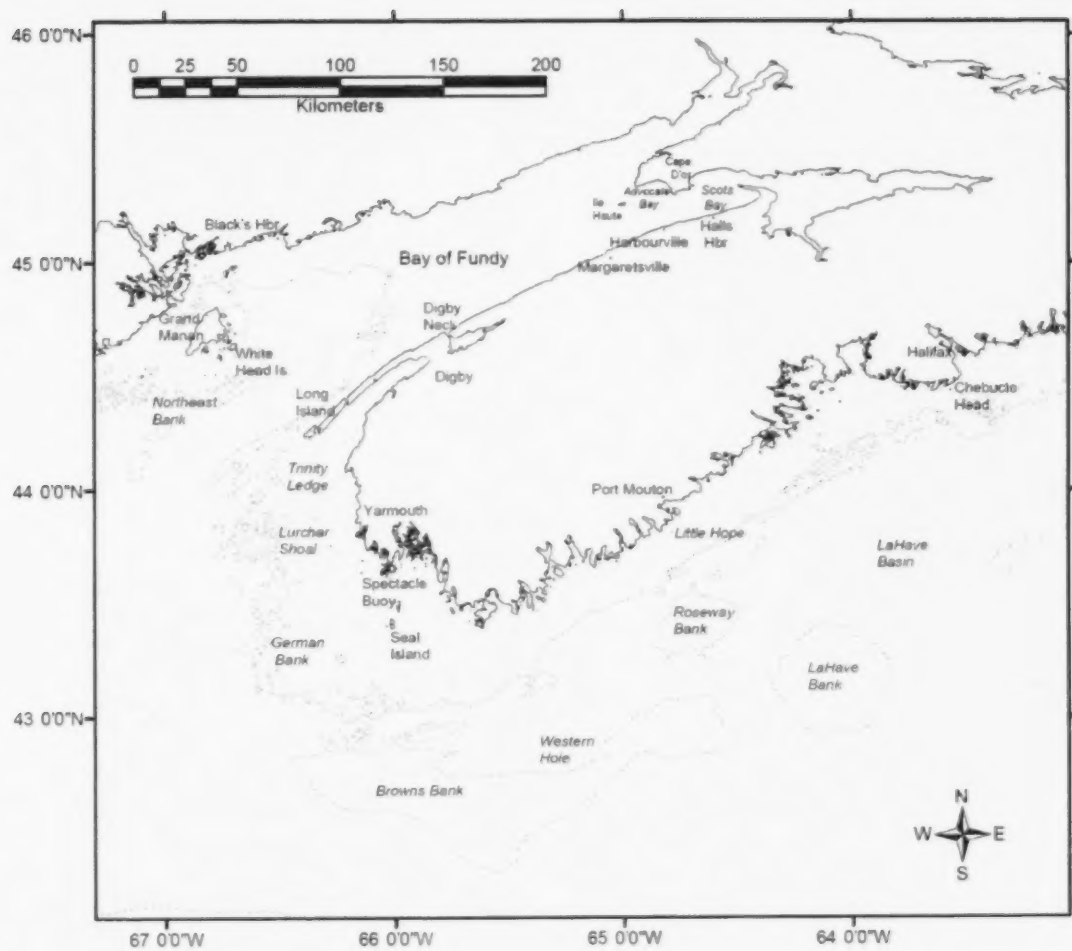
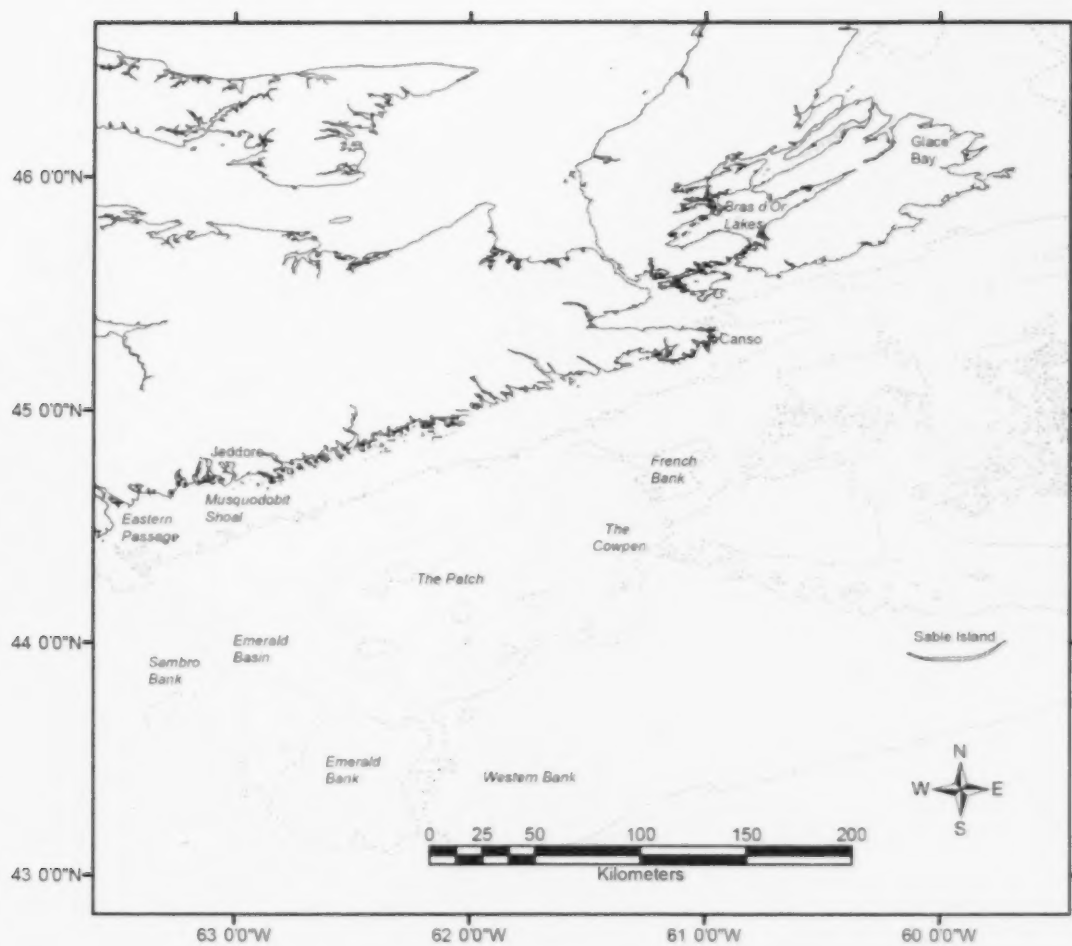Figure 2. Fishing locations for herring in southwest and coastal Nova Scotia.

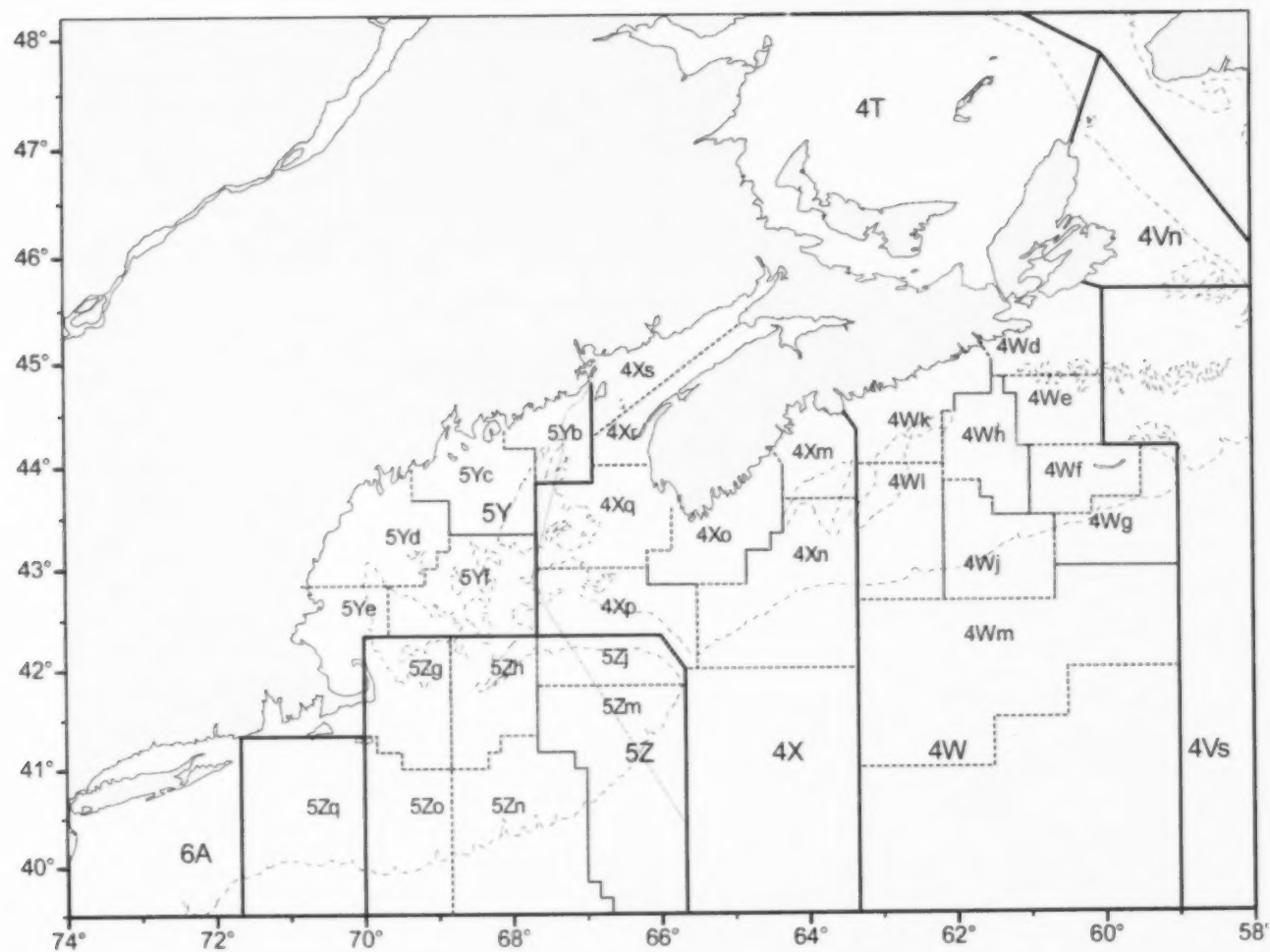Figure 3. Fishing locations for herring on the eastern Scotian Shelf and offshore banks.

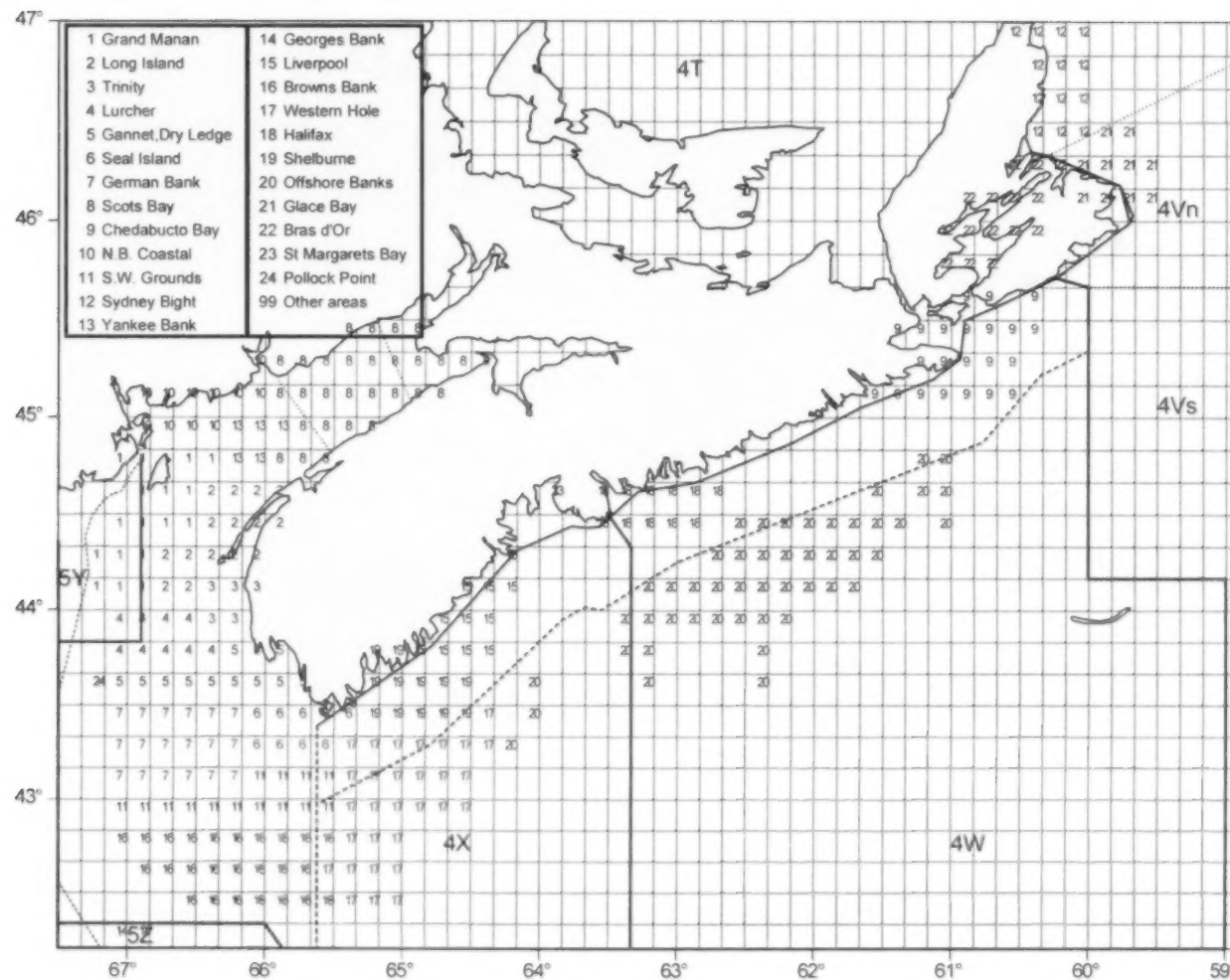Figure 4. Major and minor NAFO unit areas used for sample and catch data aggregation.

Figure 5. Herring fishing ground areas by 10 mile boxes and management lines for NAFO areas, 25 mile offshore line, coastal embayment line and herring area lines.
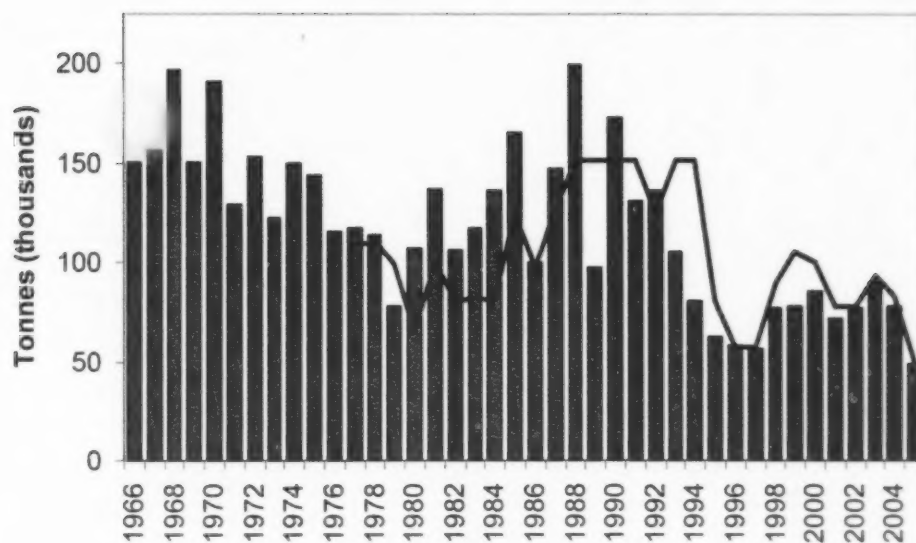
Figure 6. Annual herring landings [bars] and TAC [solid line] (quota) for the southwest Nova Scotia spawning component (4WX stock).
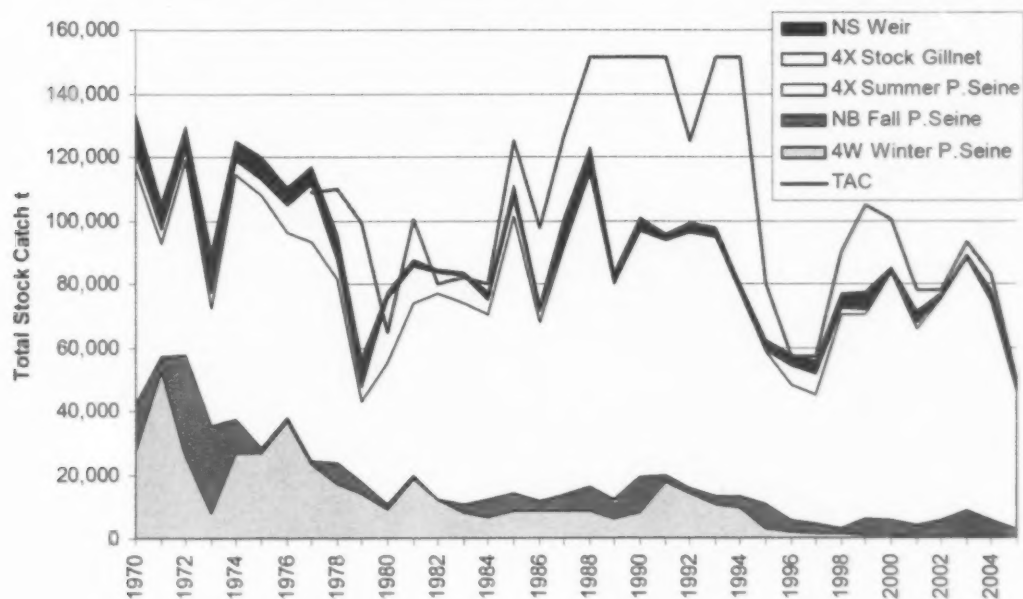
Figure 7. Annual herring landings by gear component for the southwest Nova Scotia spawning component (4WX stock).
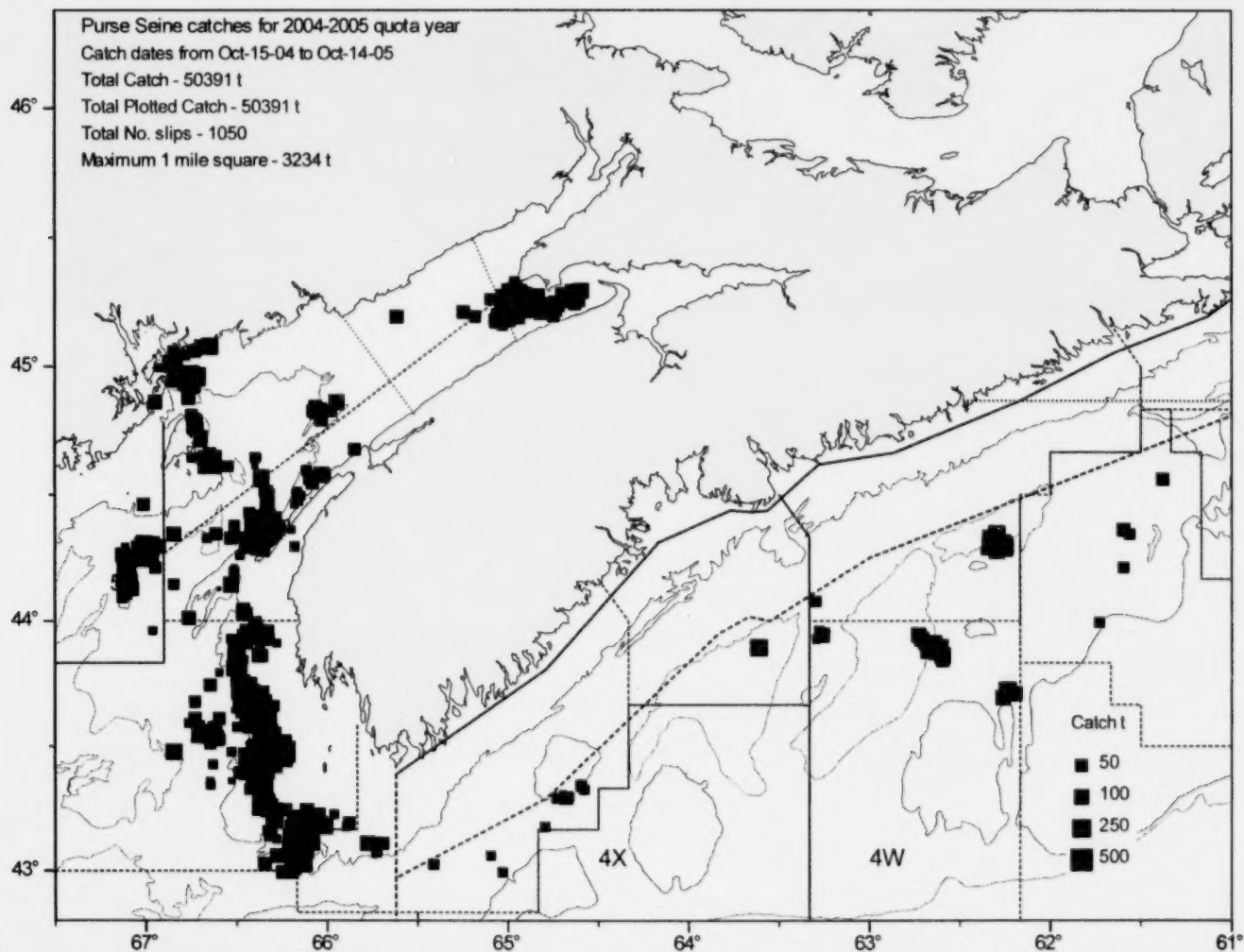
Figure 8. Overall 2004-2005 quota year herring purse seine catches (t) for NAFO areas 4WX (from Statistics Division MARFIS database).
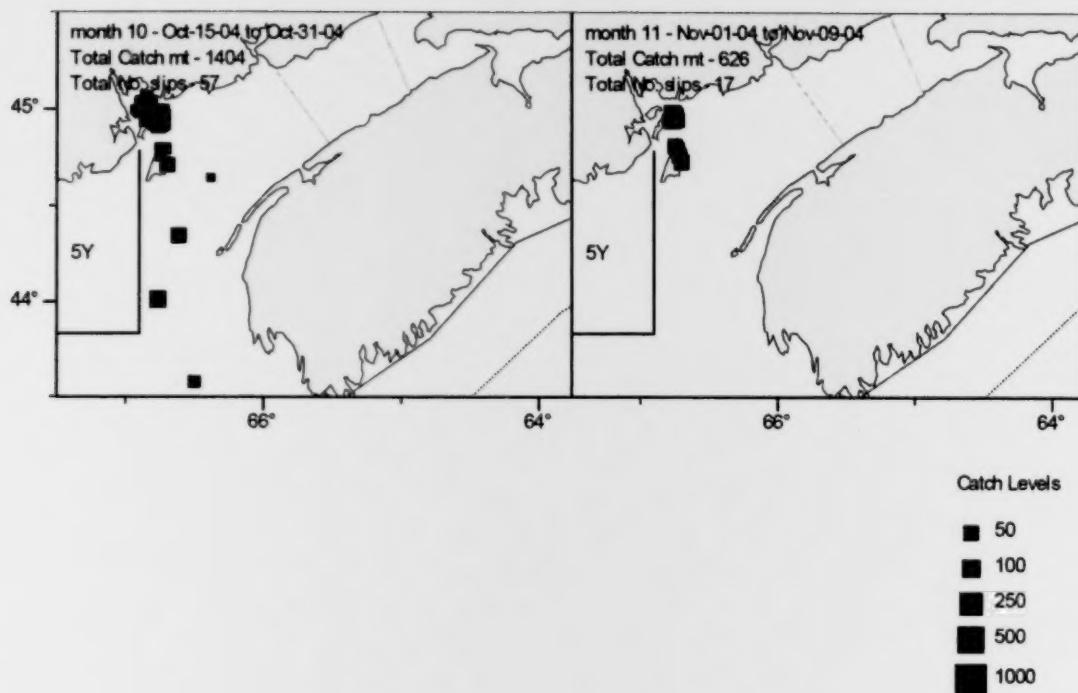
Figure 9. 2004 fall fishery herring purse seine catches (t) by month in NAFO areas 4WX from 2004-2005 quota year (from Statistics Division MARFIS database).
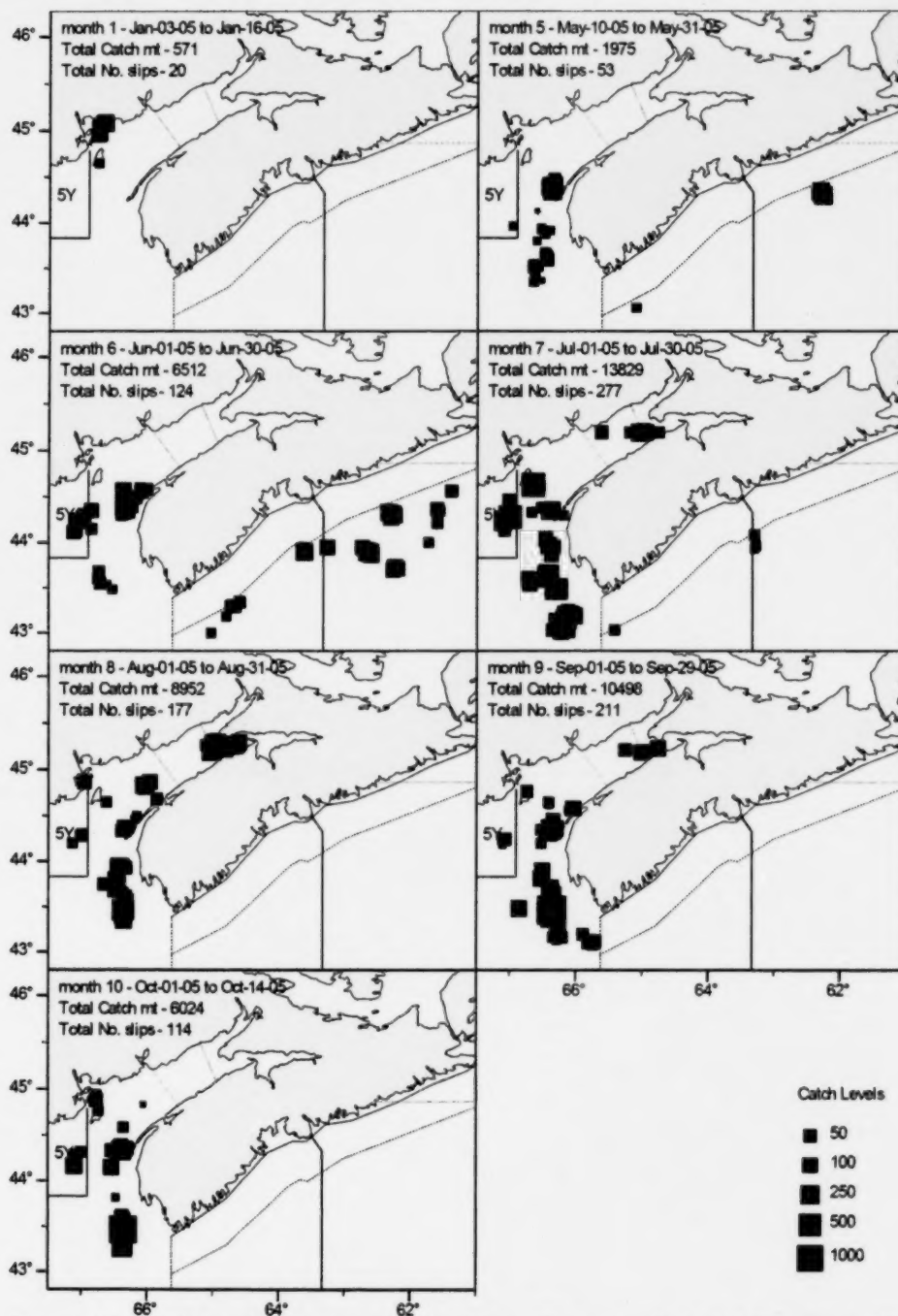
Figure 10. 2005 herring purse seine catches (t) by month in NAFO areas 4WX from 2004-2005 quota year (from Statistics Division MARFIS database).
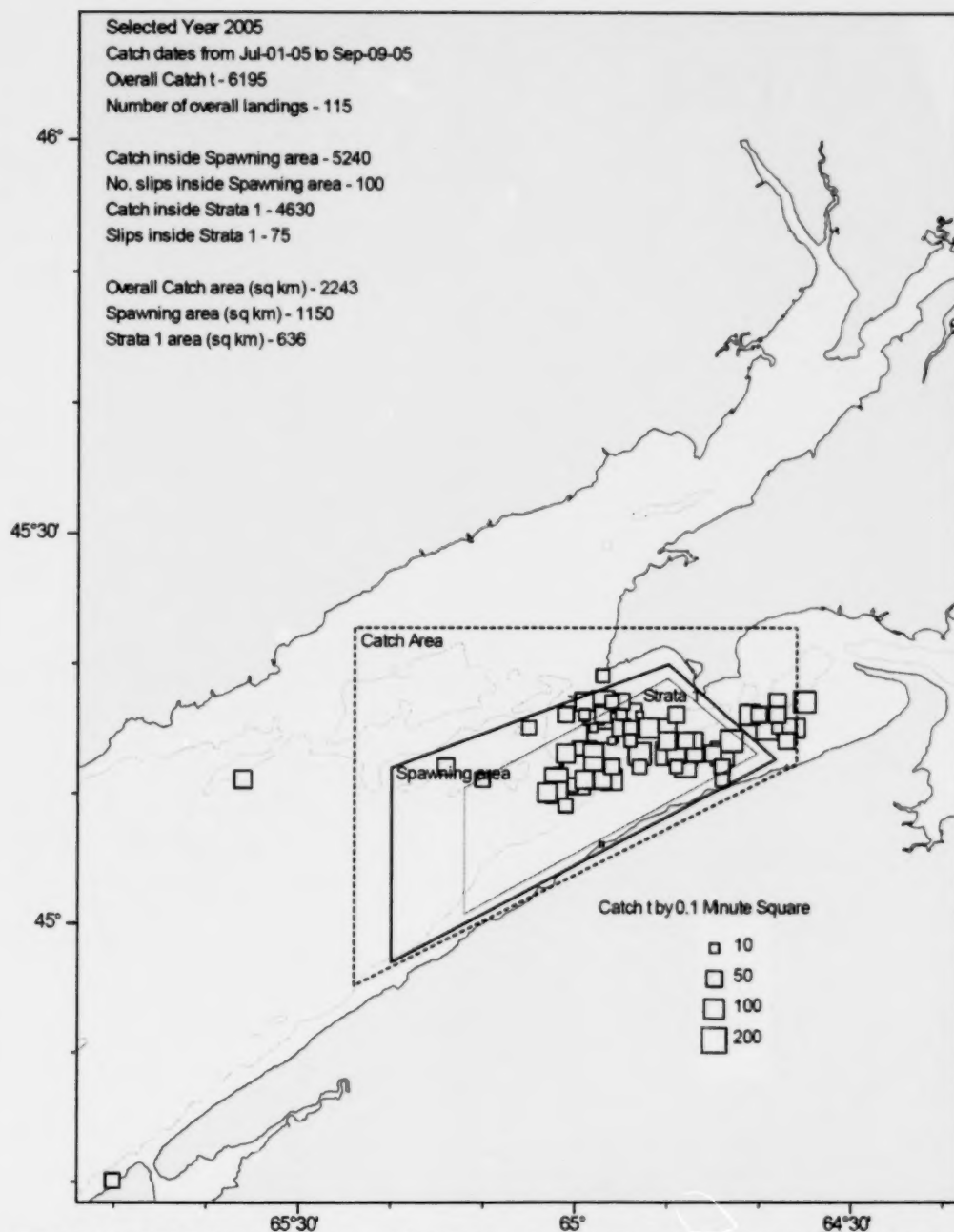
Selected Year 2005
Catch dates from Jul-01-05 to Sep-09-05
Overall Catch t - 6195
Number of overall landings - 115

Catch inside Spawning area - 5240
No. slips inside Spawning area - 100
Catch inside Strata 1 - 4630
Slips inside Strata 1 - 75

Overall Catch area (sq km) - 2243
Spawning area (sq km) - 1150
Strata 1 area (sq km) - 636

Figure 11. 2005 Scots Bay spawning fishery (catches t and area in km^2) for the entire fishing period in the selected 'Catch Area', 'Spawning Area' and the primary acoustic survey area (Stratum 1).
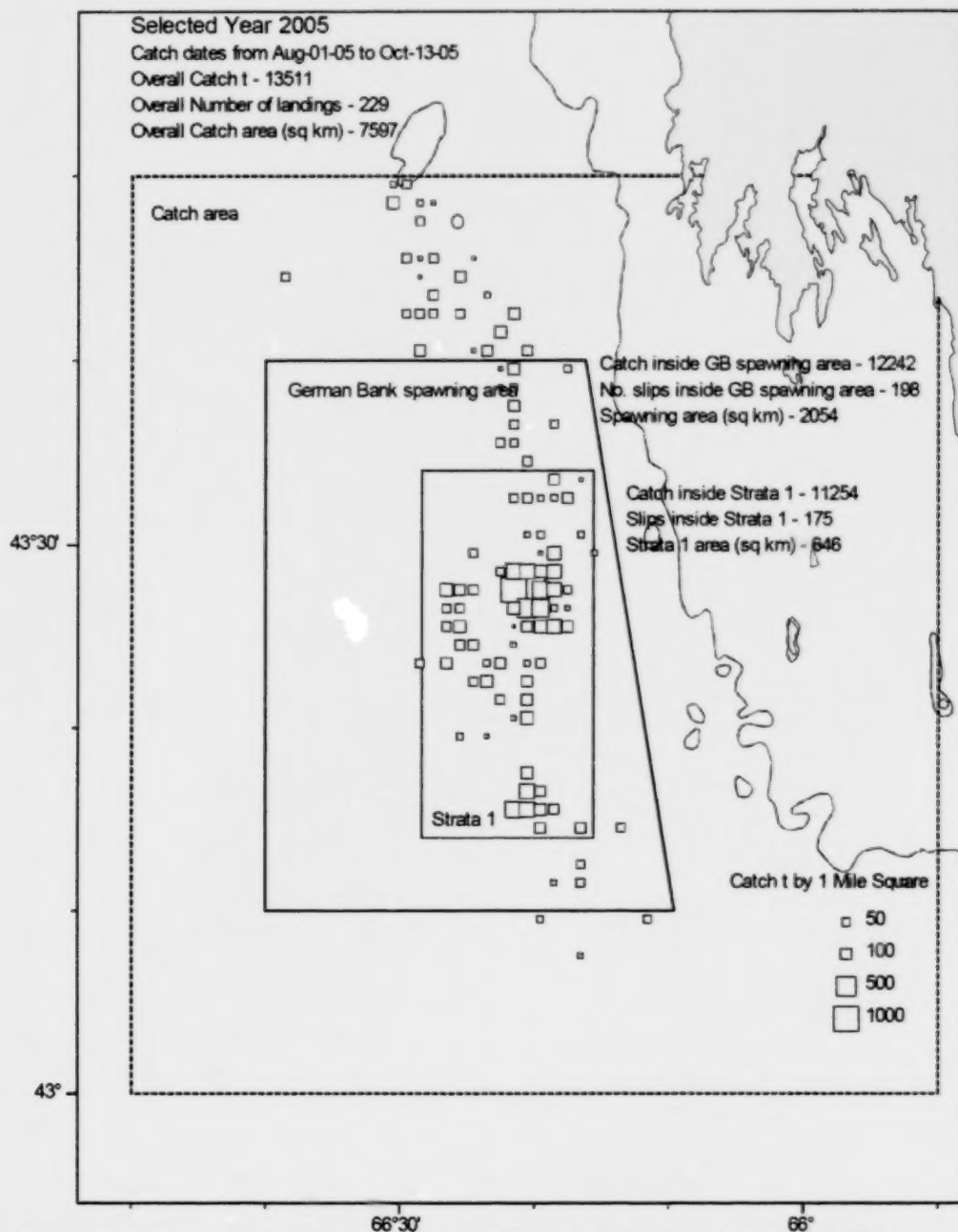
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Figure 12. 2005 German Bank spawning fishery (catches t and area in km^2) for the spawning period Aug. 1 to Oct. 15, 2005 in the selected 'Catch Area', 'Spawning Area' and the primary acoustic survey area (Stratum 1).

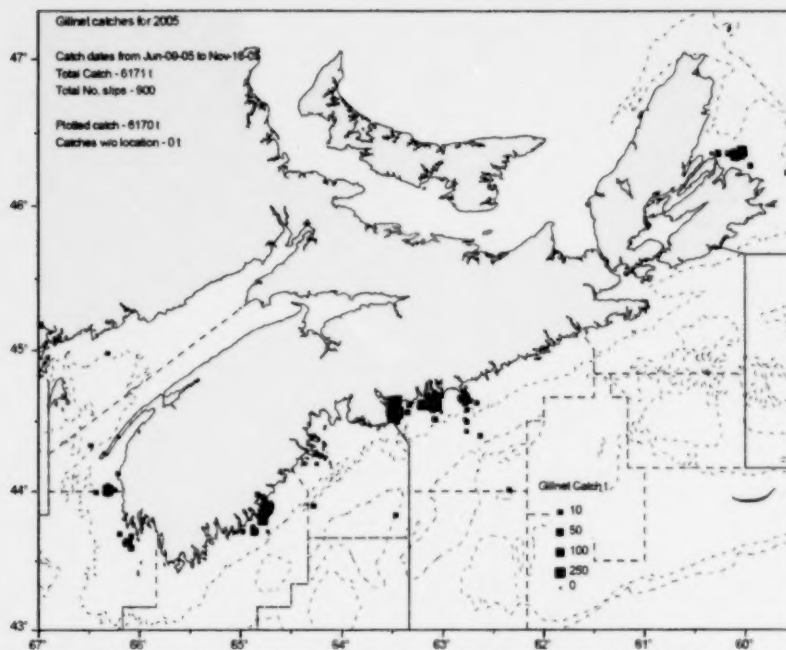Figure 13. Herring set and drift gillnet catches (t) for 2005 calendar year for NAFO areas 4VWX (data from Statistics Division MARFIS database).
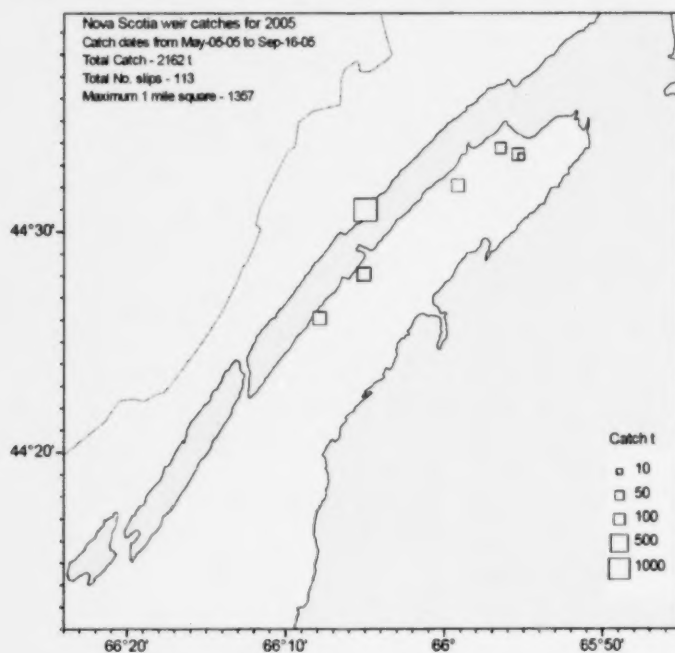

Figure 14. Nova Scotia herring weir catches for the 2005 calendar year.

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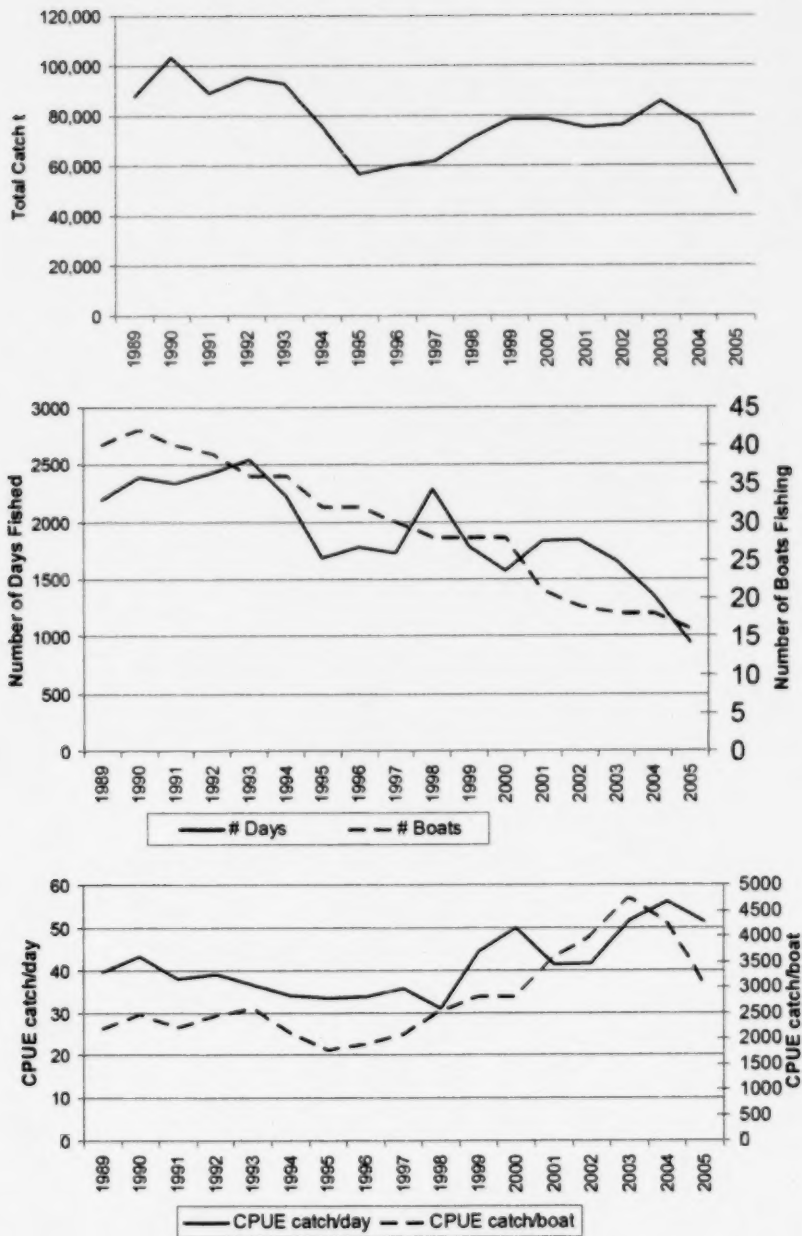
Figure 15. Purse seine catch (top panel), effort (middle panel) and CPUE (bottom) from 1989 to 2005 annual 4WX herring landings data for the SW Nova Scotia/Bay of Fundy spawning component.
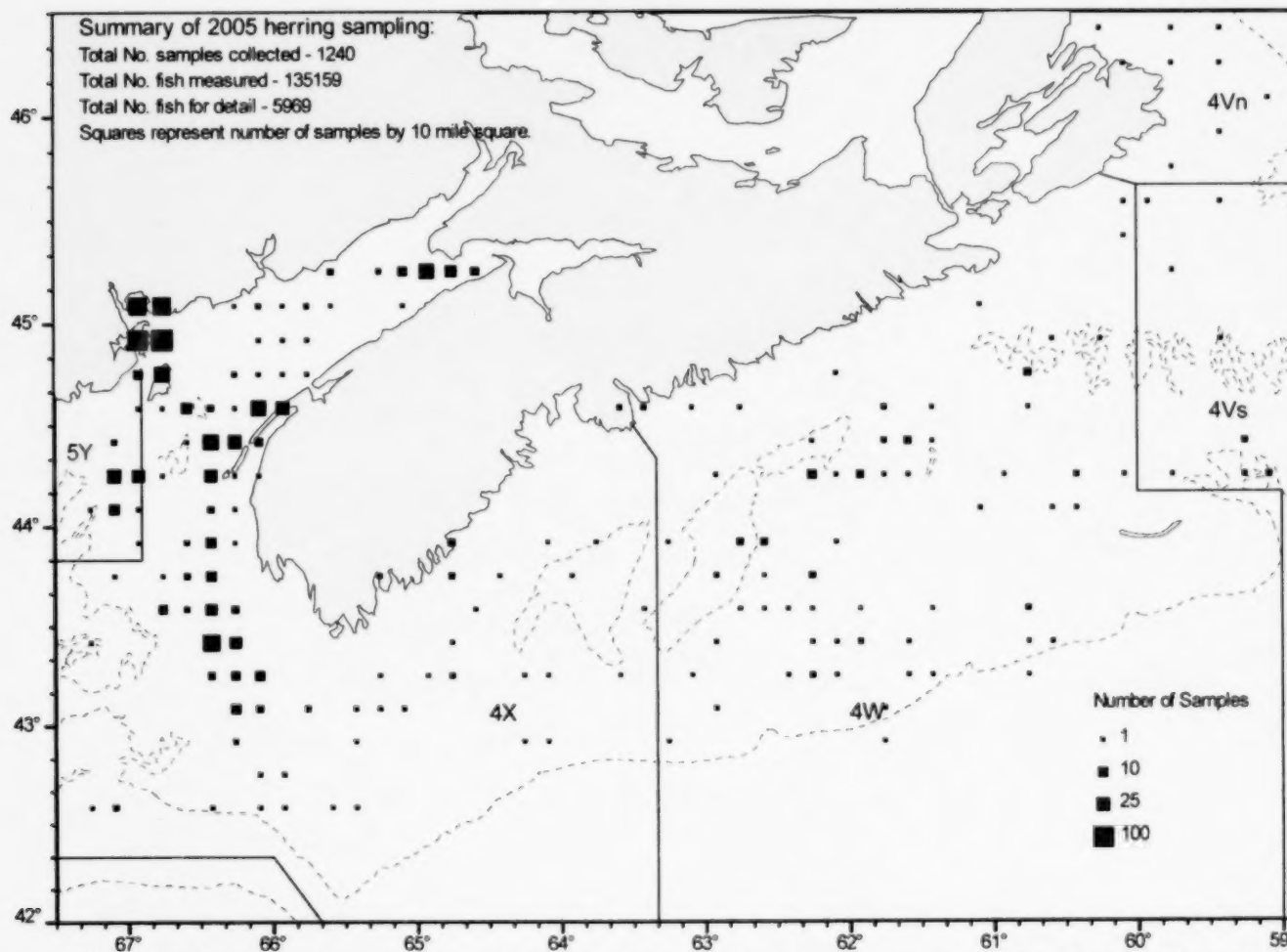
Figure 16. 2005 herring sampling coverage from all sources (number of length frequency samples by 10 mile square).
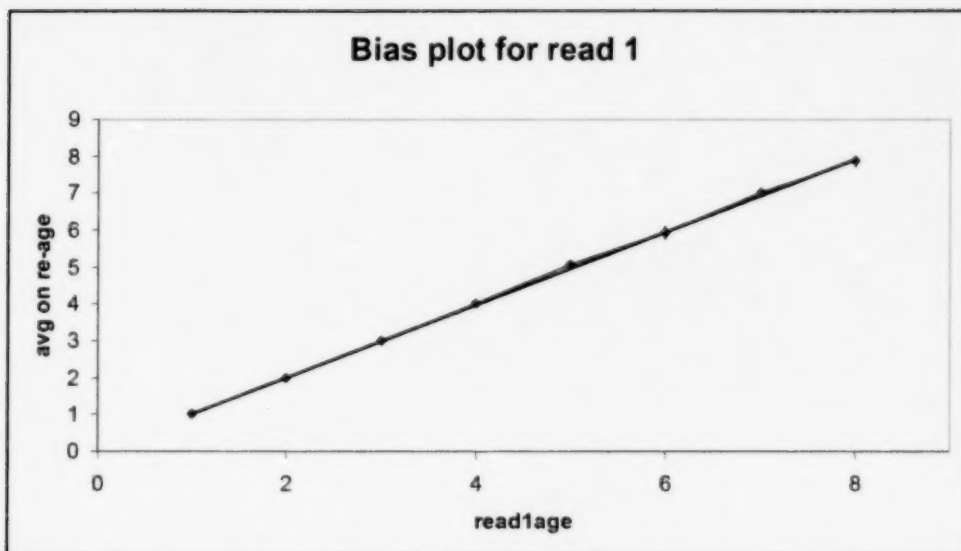
Figure 17. Bias plot of the first and second reading of herring otoliths from the 2005 4VWX fishery (random sample of 143 otoliths). The mean CV was 1.45%
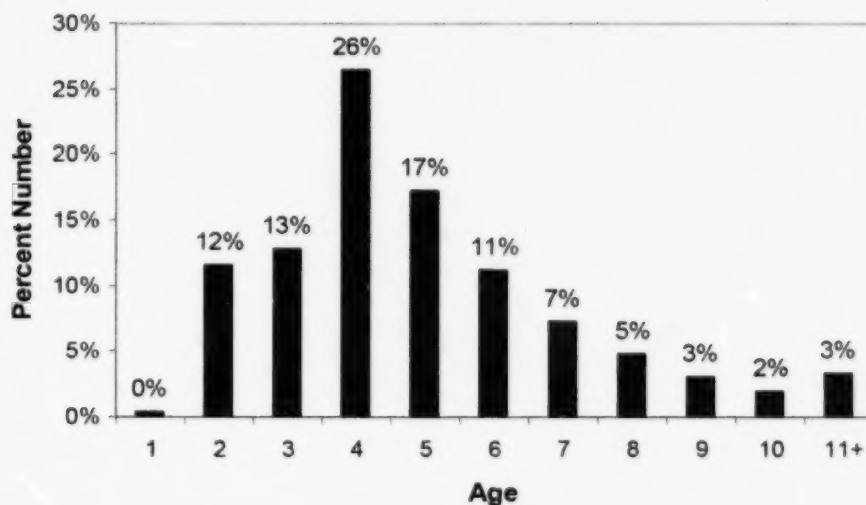
Figure 18. Expected age structure in the fishery with fishing at $F_{0.1}$ and constant average recruitment. Parameters: long-term F=0.23, annual recruitment=1.8 billion, natural mortality=0.2, partial recruitment vector=0.006, 0.235, 0.339 and 1 for ages 1, 2, 3 and 4+, respectively.
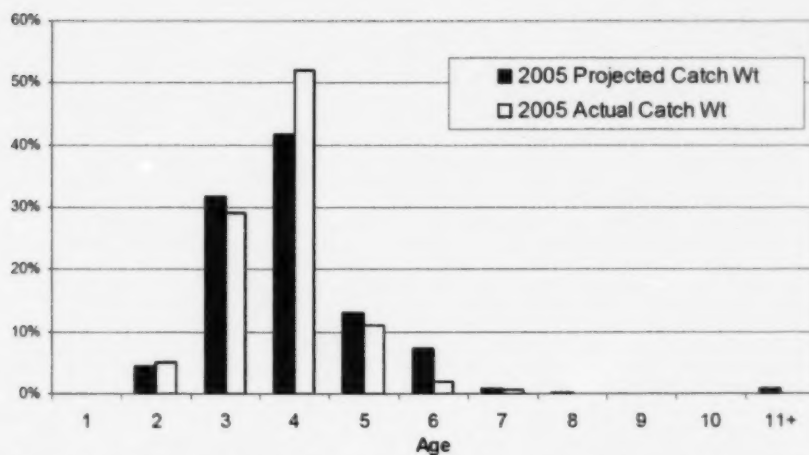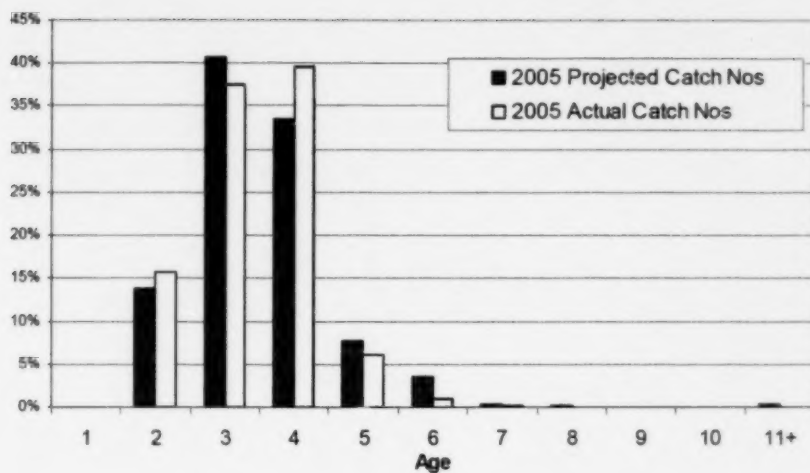
Figure 19. Projected 2005 age structure based on fishing at $F_{0.1}$ and actual 2005 catch in percent numbers (top panel) and percent weight (bottom panel).
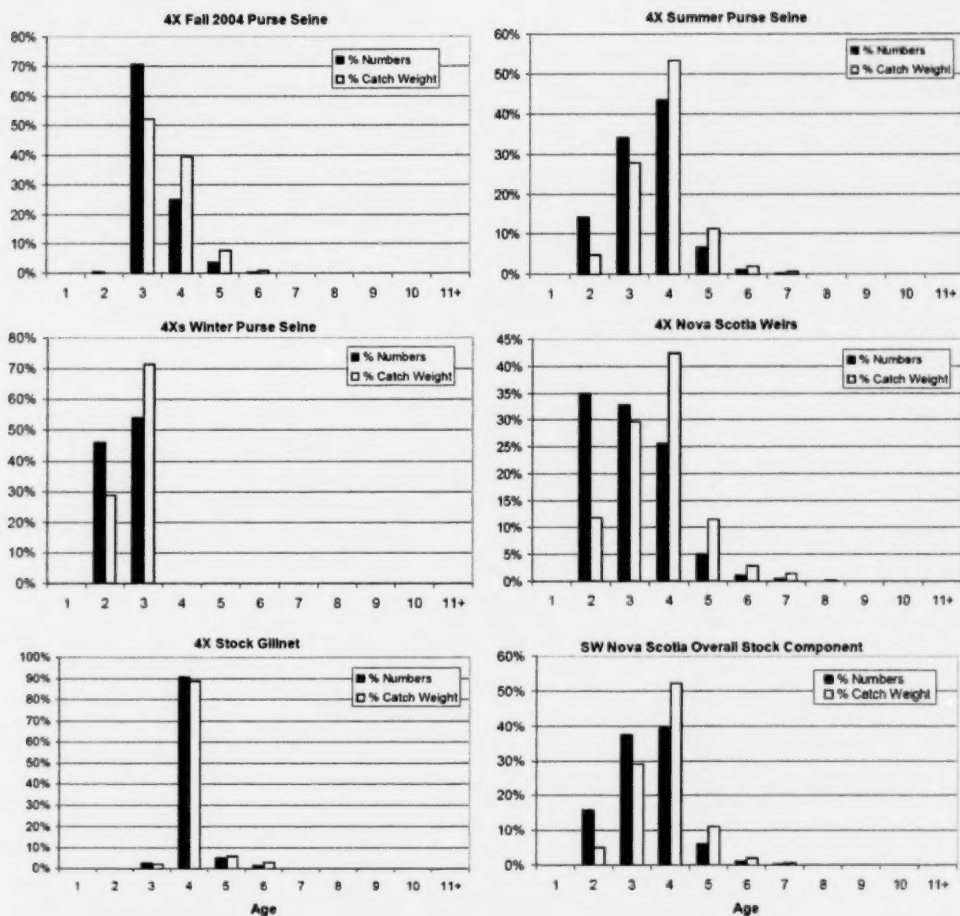
Figure 20. Catch at age for the 2005 SW Nova Scotia / Bay of Fundy spawning component (% numbers and % weight) by gear type.
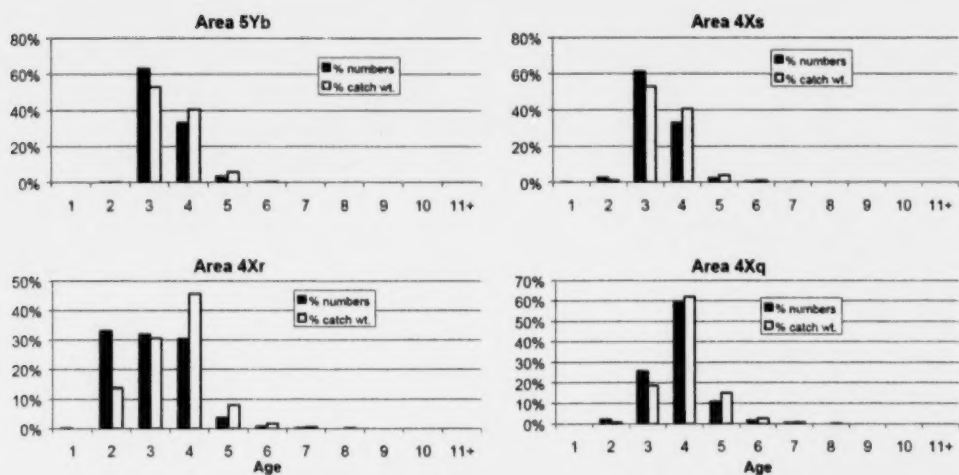
Figure 21. Herring catch at age by NAFO unit area for the 2005 summer purse seine fishery conducted on the SW Nova Scotia / Bay of Fundy spawning component.
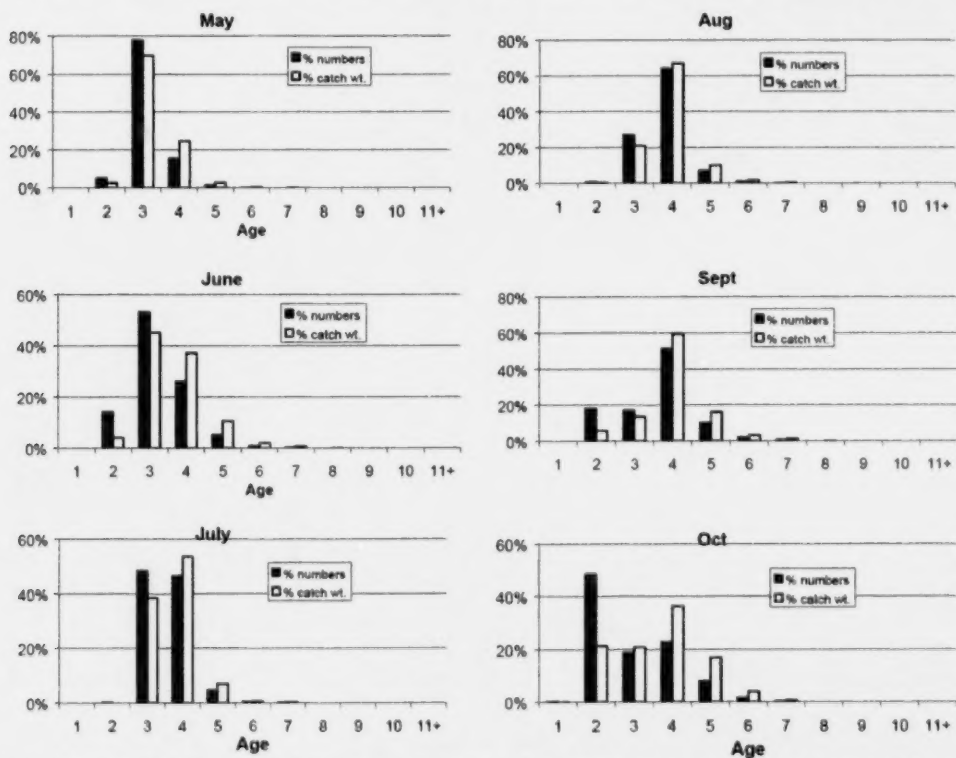
Figure 22. Herring catch at age by month for the 2005 summer purse seine fishery conducted on the SW Nova Scotia / Bay of Fundy spawning component.
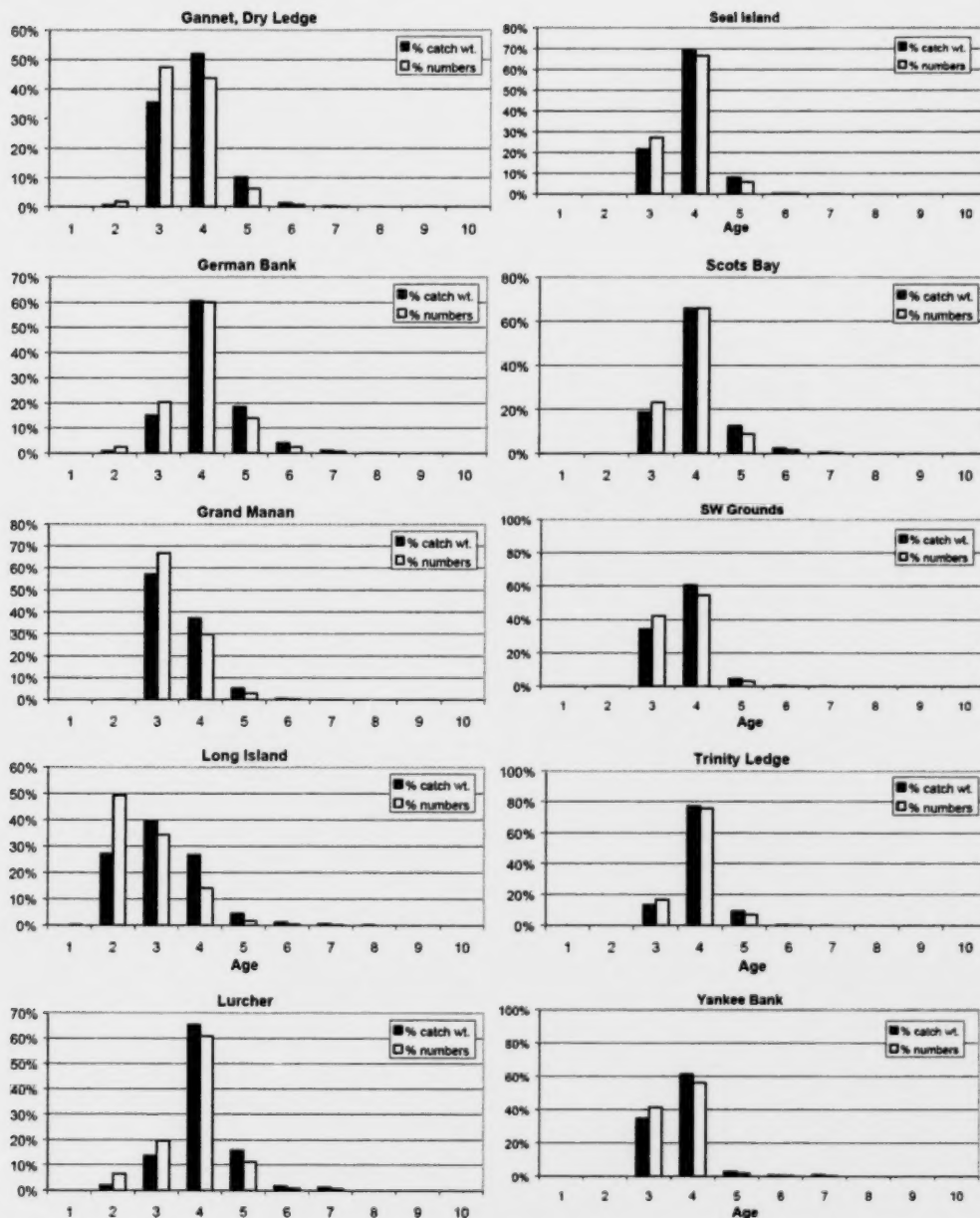
Figure 23. Herring catch at age by fishing ground for the 2005 summer purse seine fishery conducted on the SW Nova Scotia / Bay of Fundy spawning component.
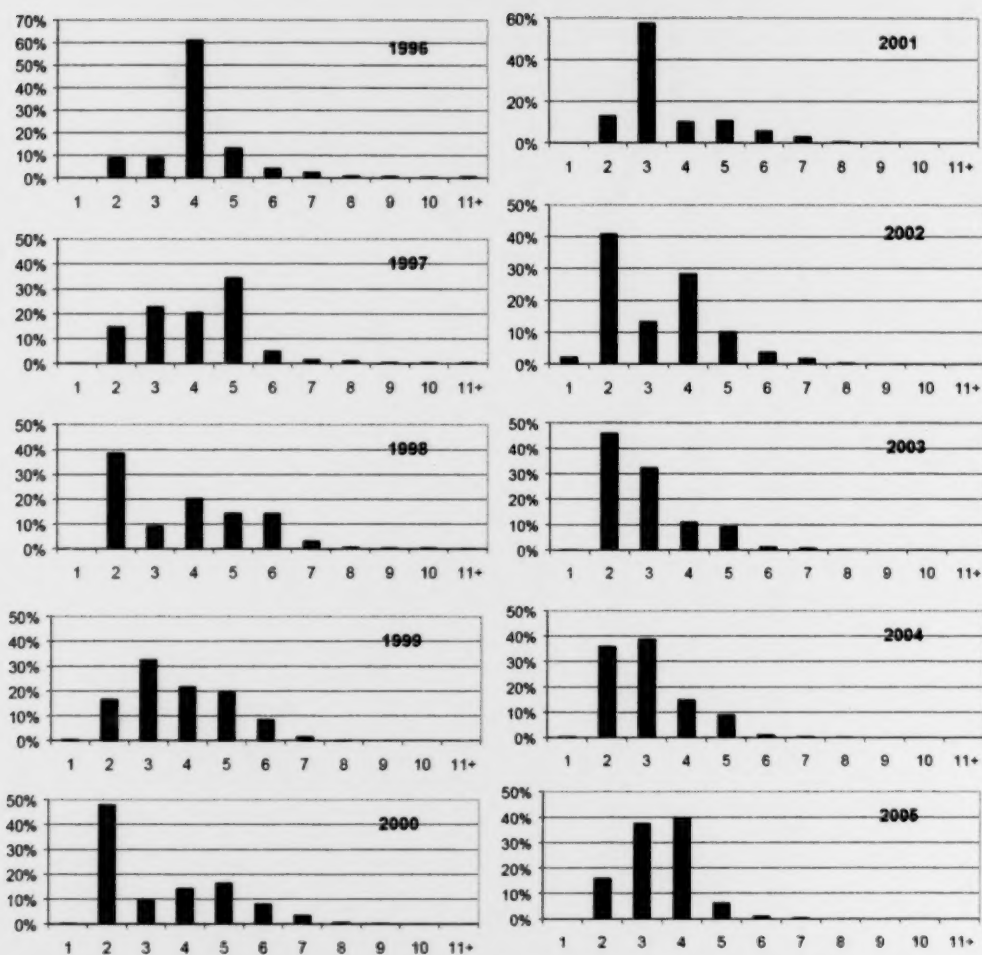
Figure 24. Catch at age (% numbers) for the SW Nova Scotia / Bay of Fundy spawning component (4WX stock) for the most recent 10 years (1996 to 2005).
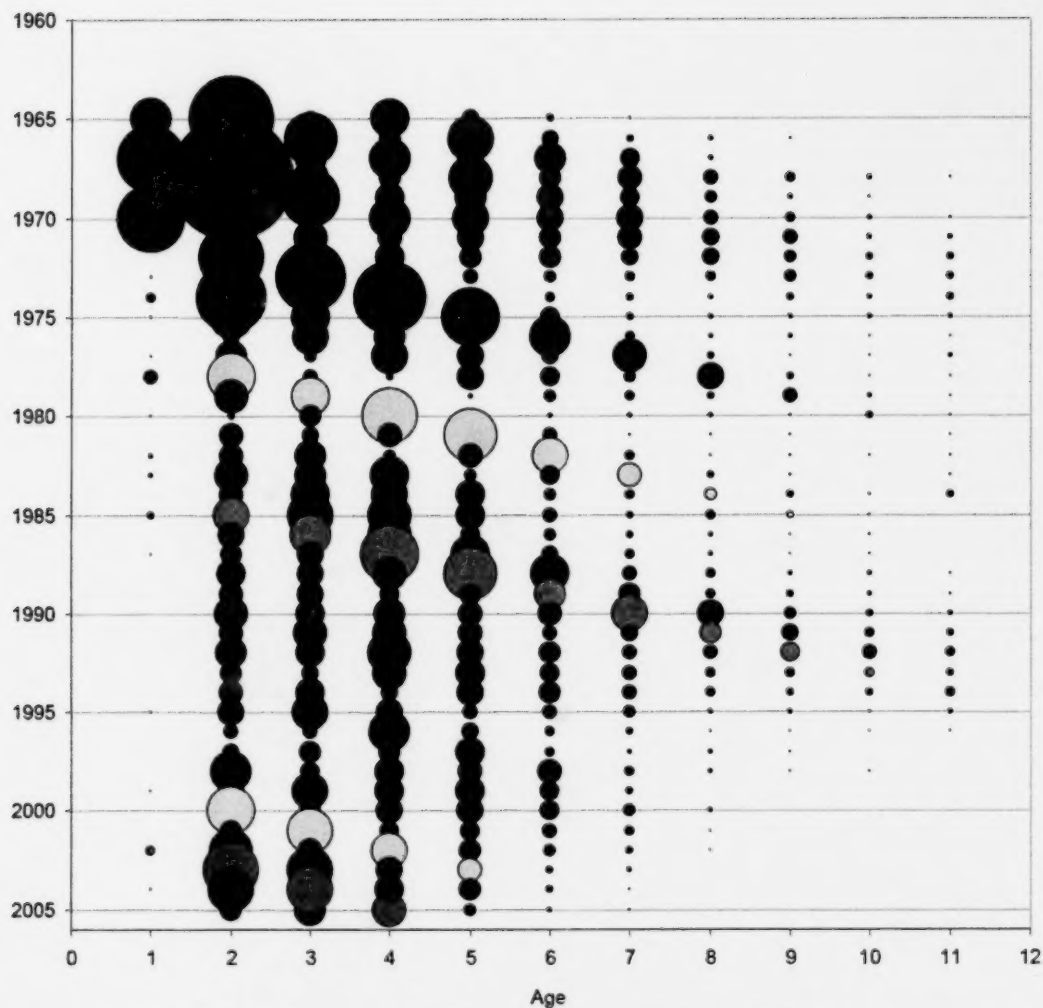
Figure 25. Historical catch at age (numbers) for the SW Nova Scotia / Bay of Fundy spawning component. Refer to Table 18 for actual numbers represented by symbol size. The value for 1968 at age 2 represents the maximum in the series of 2.389 billion. Several of the stronger year-classes are highlighted including the 1970, 1976, 1983, 1998 and 2001 year-classes.
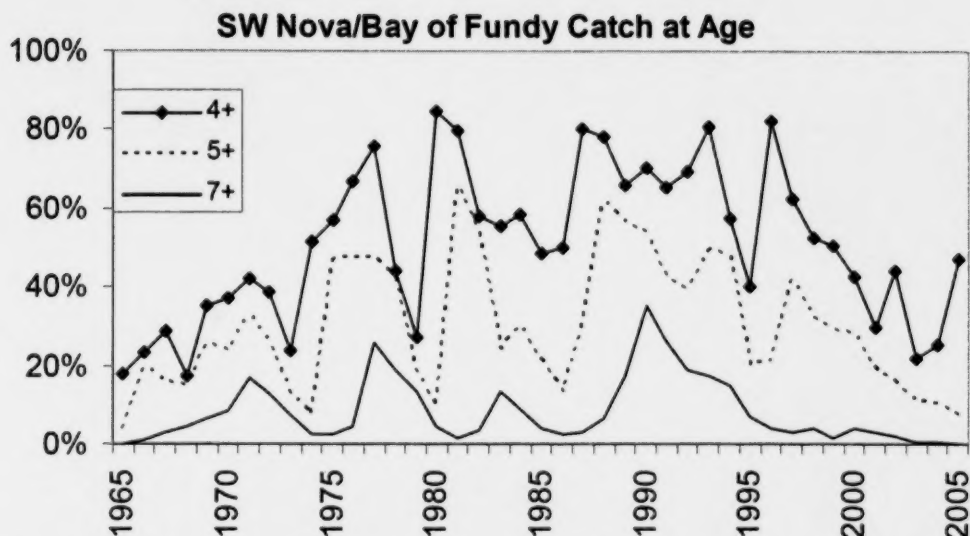
Figure 26. Overall proportions (percent numbers) of ages 4+, 5+ and 7+ in the catch at age for the SW Nova Scotia / Bay of Fundy spawning component for the period 1965 to 2005.
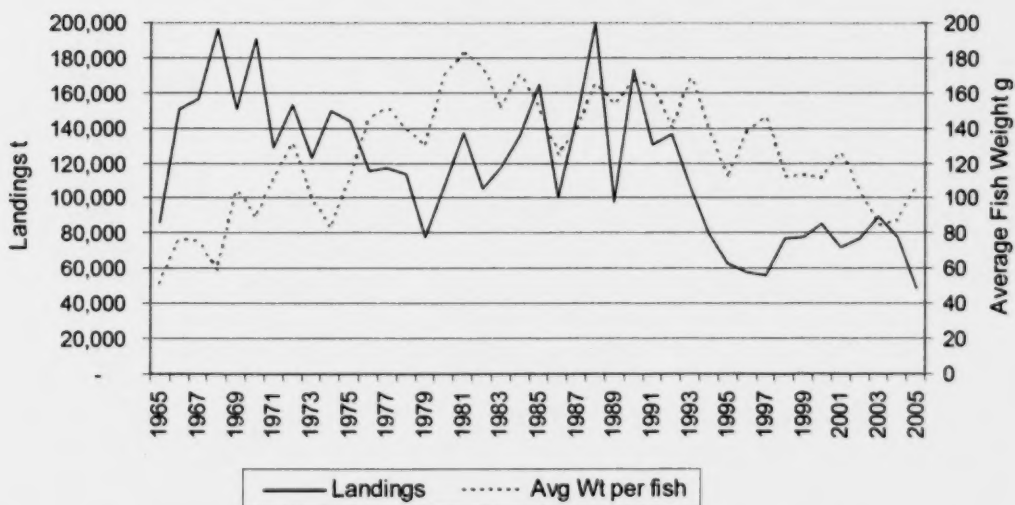
Figure 27. SW Nova Scotia / Bay of Fundy spawning component overall landings (t) and average fish weight in the catch for the period 1965 to 2005.

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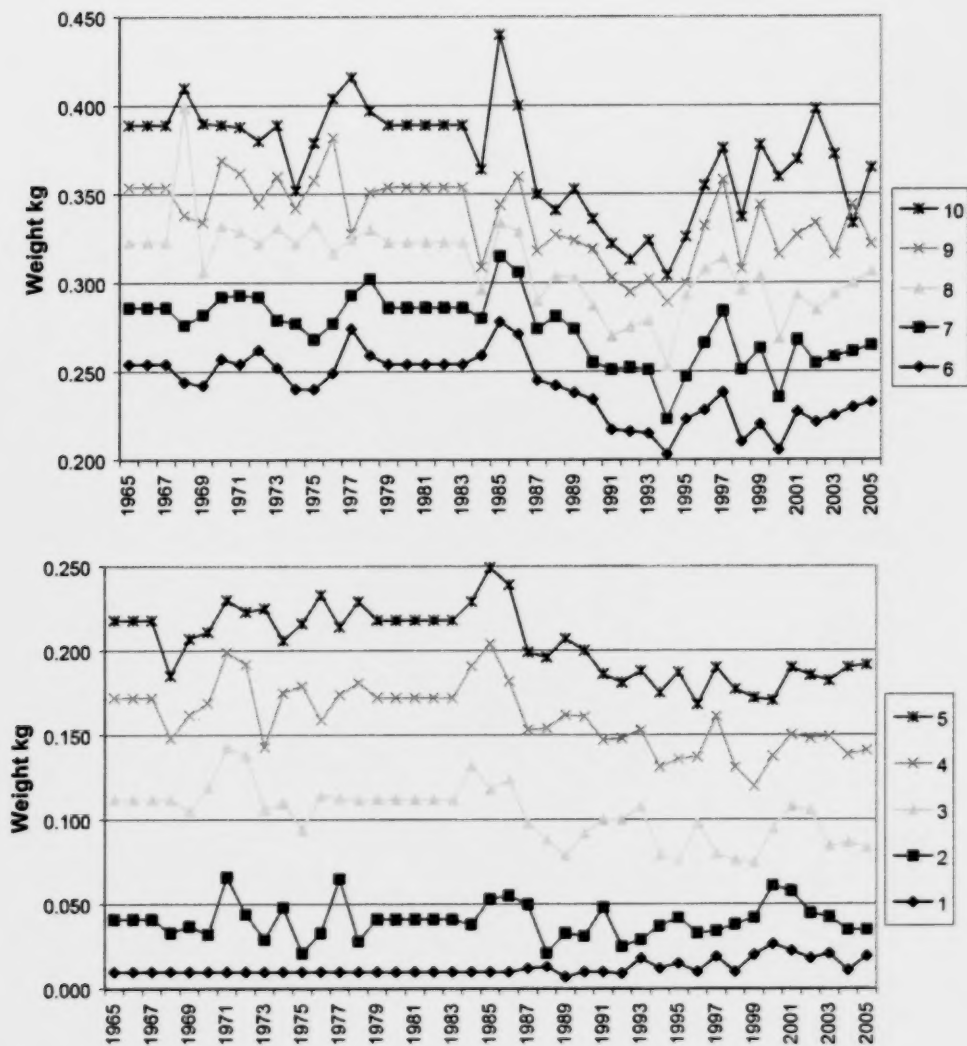
Figure 28. Average weights at age (kg) for the SW Nova Scotia / Bay of Fundy component of the 4WX herring fishery (fishery weighted) for 1965-2005.
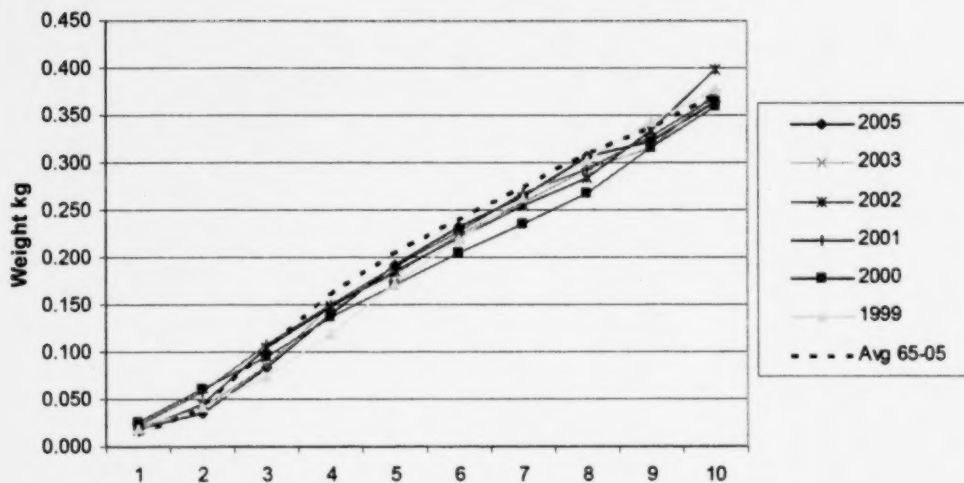
Figure 29. Average weights at age (kg) for the SW Nova Scotia / Bay of Fundy component of the 4WX herring fishery (fishery weighted) for the most recent 5 years individually and the historical series.
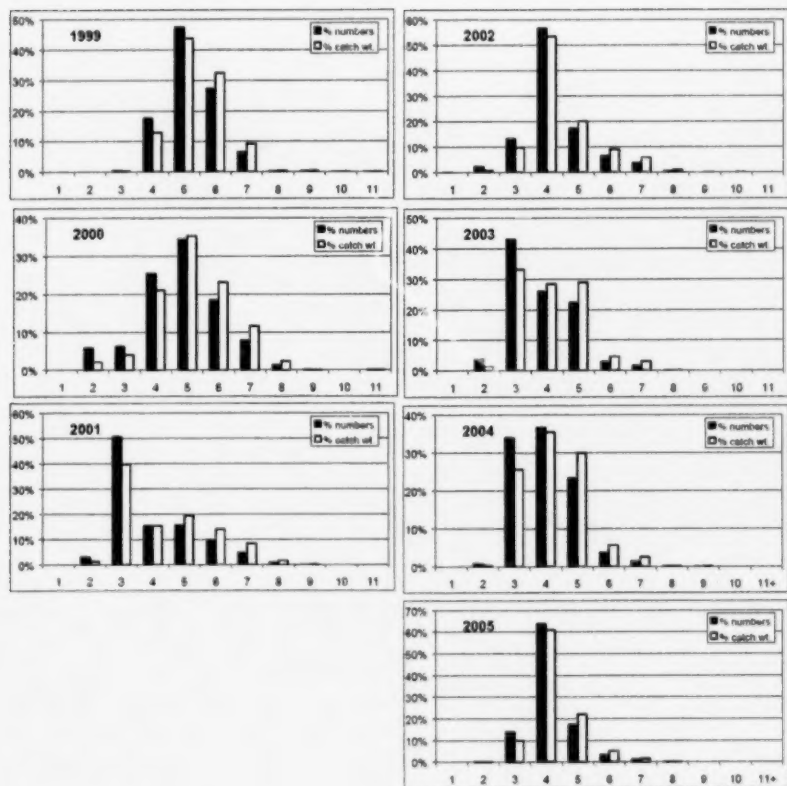
Figure 30. Catch at age by year from the herring acoustic surveys for the overall SW Nova Scotia/Bay of Fundy spawning component.
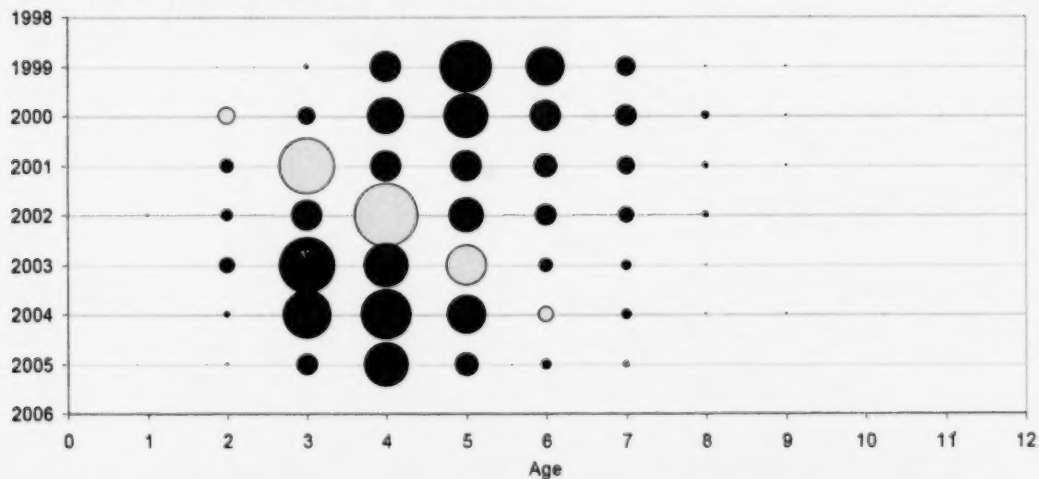
Figure 31. Acoustic survey catch at age (numbers) for the SW Nova Scotia / Bay of Fundy spawning component.
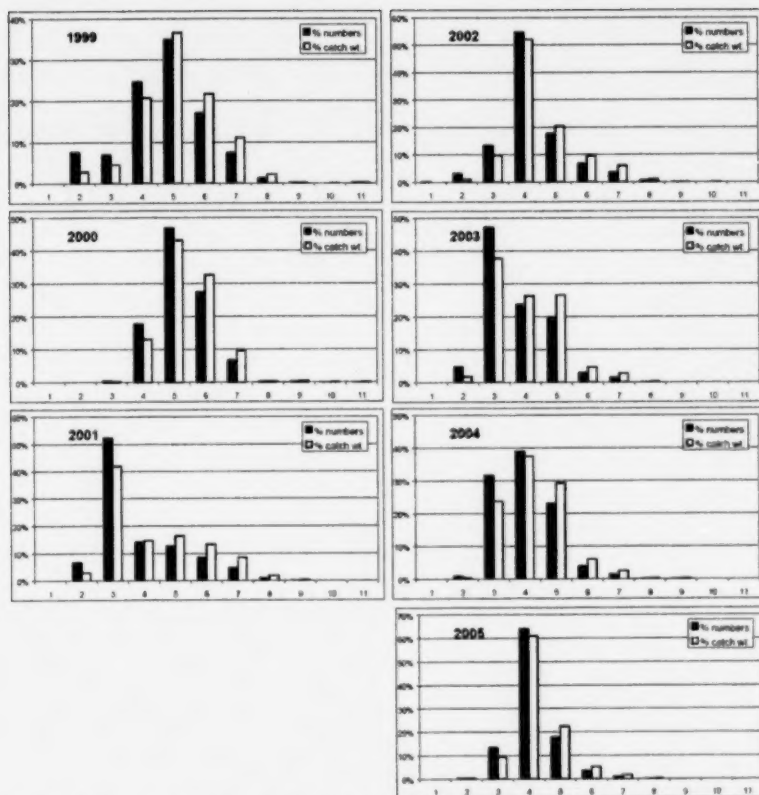
Figure 32. Catch at age by year from the herring acoustic surveys for the German Bank only spawning component.
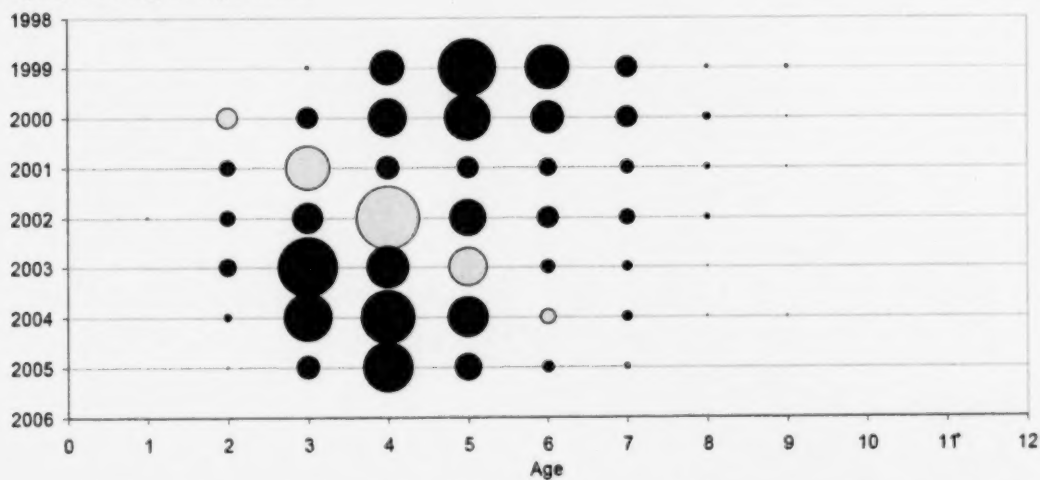
Figure 33. Acoustic survey catch at age (numbers) for the German Bank only spawning component

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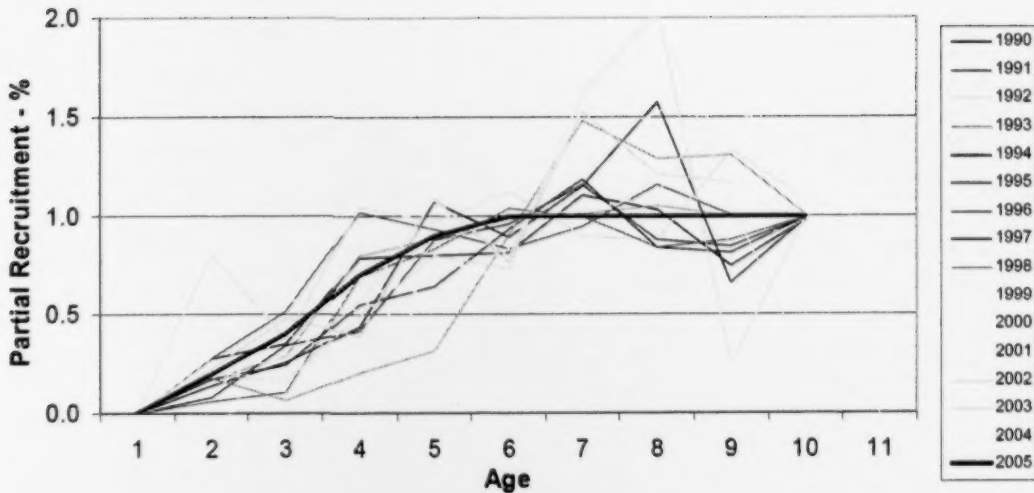
Figure 34. Exploitation pattern at age by year for 1990-2004 from the initial VPA. The 2005 line represents the assumptions made in the terminal year.
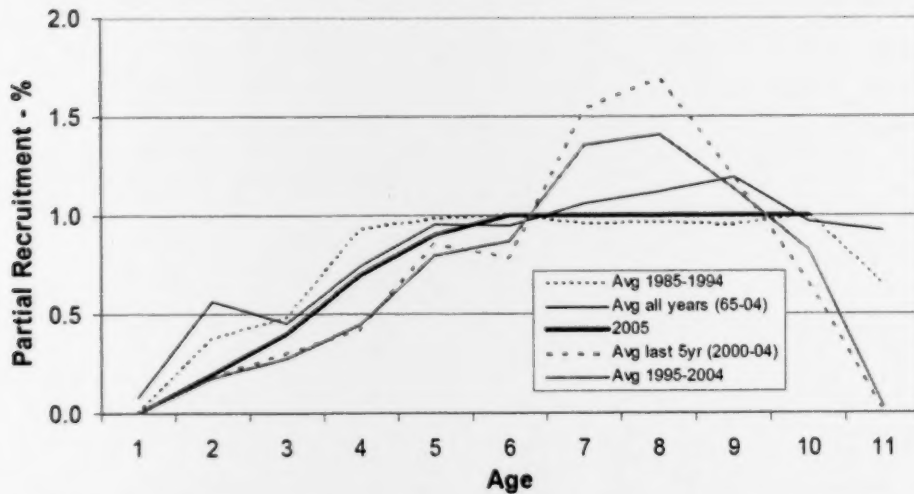
Figure 35. Exploitation pattern at age for various periods from the initial VPA. The 2005 line represents the assumptions made in the terminal year.
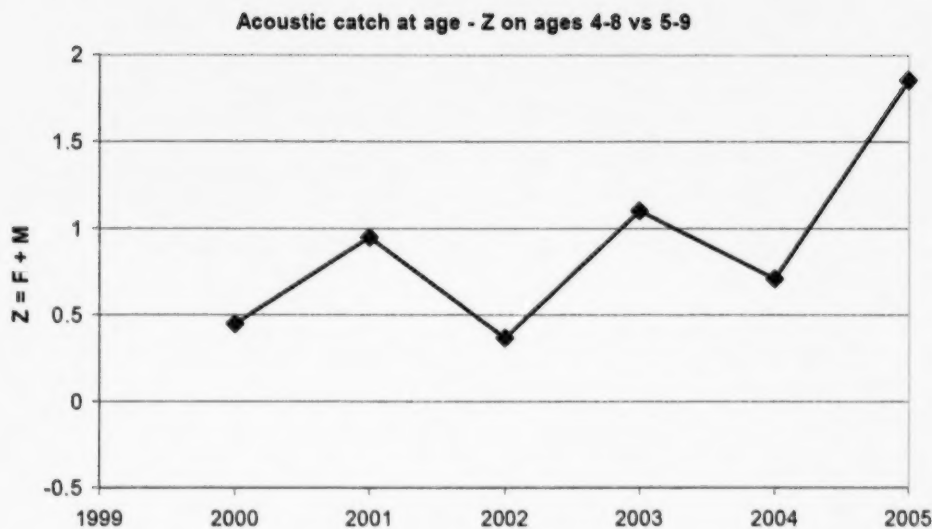
Figure 36. Total mortality estimates (Z=F+M) from acoustic catch at age data for ages 4 to 8 compared with ages 5 to 9 in the following year.
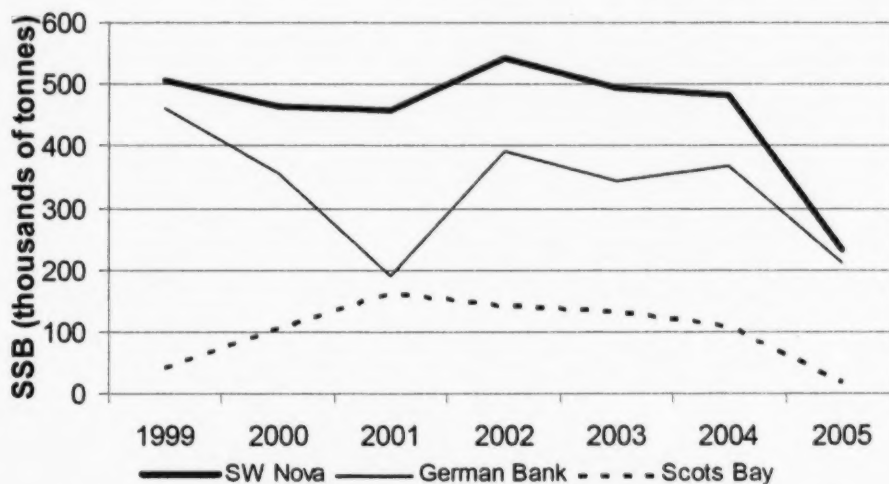
Figure 37. SSB index from acoustic surveys for the SW Nova Scotia / Bay of Fundy spawning component ('SW Nova' values are from the 'Subtotal' row in Table 9).

	Parameter	Estimate	Standard Error	Bias	%SE	% Bias	Avg Squared Residual
1	N[2006 7]	2457.55	2102.42	735.34	86%	30%	2.54
2	q ID#[1]	0.03	0.02	0.00	63%	18%	7.09
3	q ID#[2]	0.94	0.59	0.17	62%	18%	2.32
4	q ID#[3]	5.38	3.33	0.99	62%	18%	0.41
5	q ID#[4]	15.18	9.38	2.82	62%	19%	0.33
6	q ID#[5]	16.65	10.29	3.12	62%	19%	0.08
7	q ID#[6]	43.63	26.94	8.20	62%	19%	0.46
8	q ID#[7]	42.12	26.02	7.89	62%	19%	0.96
9	q ID#[8]	18.01	11.76	3.70	65%	21%	5.90
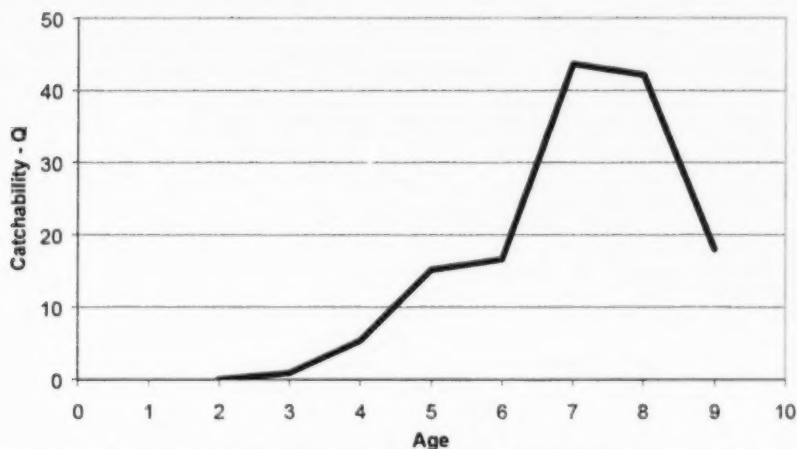
Figure 38. Parameter estimates and plot of catchability by age (Q) from initial VPA run.
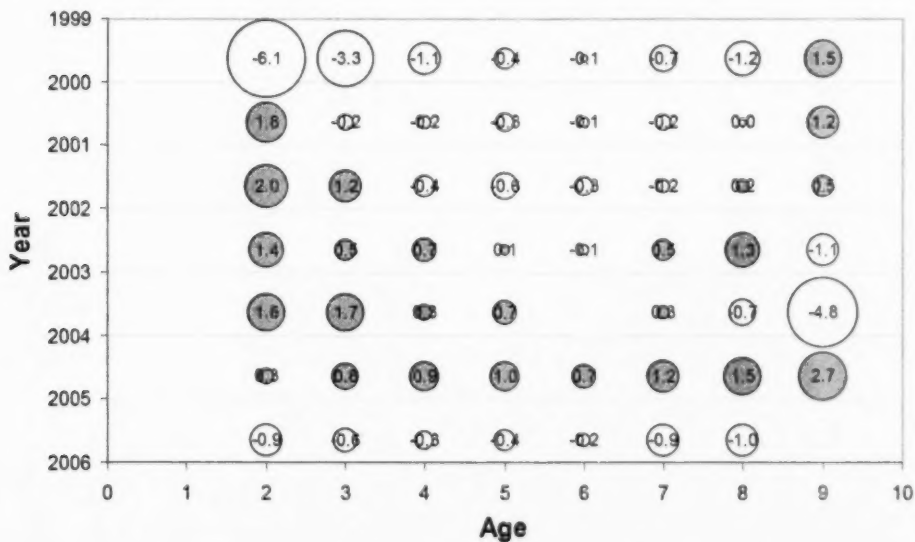
Figure 39. Residuals by age and year from the initial VPA. Circle area is proportional (on a linear scale) to the magnitude of the residual with the predicted values.
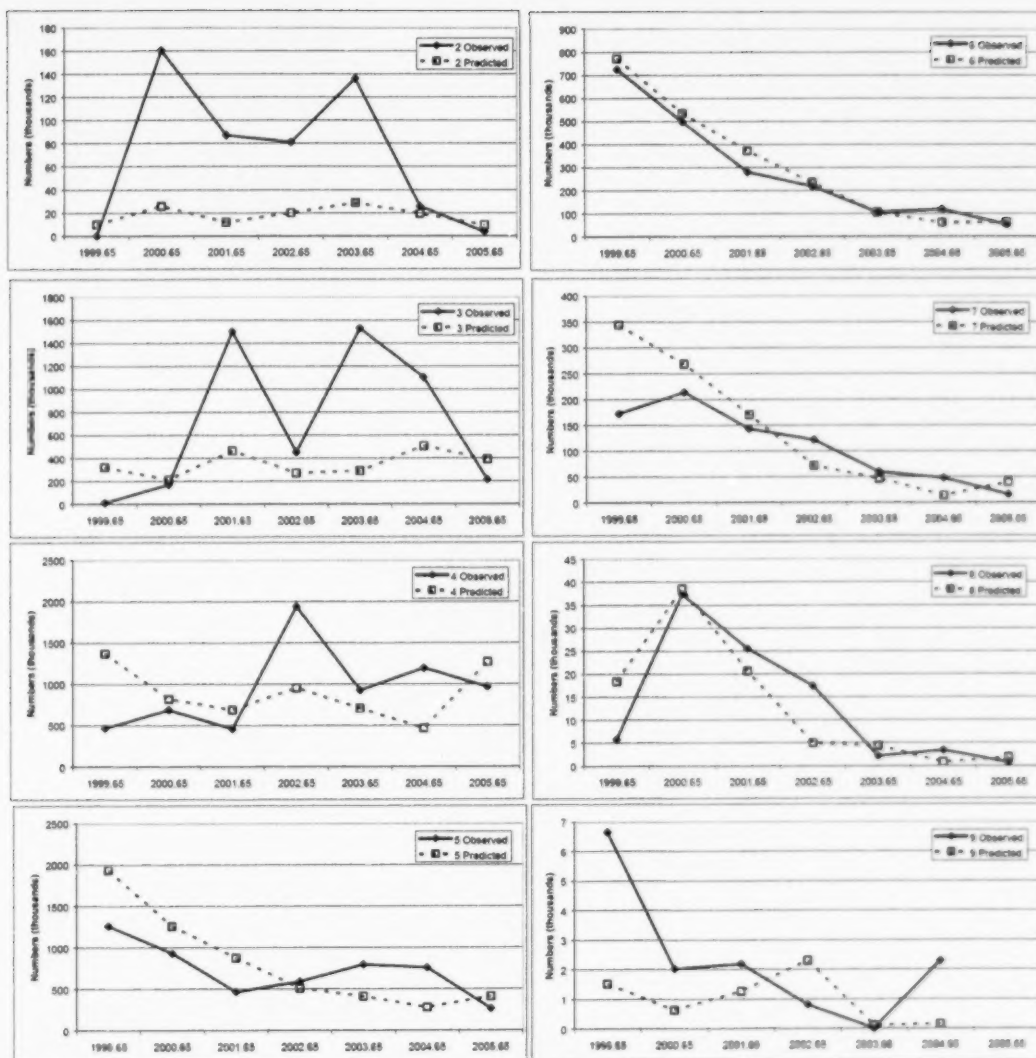
Figure 40. Age by age plots of the observed abundance index and predicted population numbers versus year from an initial VPA using last year's formulation.

Age	Parameter	Estimate	Standard Error	Bias	%SE	% Bias	Mean Square Residual
1	N[2006 7]	1543.98	761.49	164.71	49%	11%	0.53
4	q ID#[3]	5.76	1.66	0.22	29%	4%	0.43
5	q ID#[4]	16.25	4.69	0.64	29%	4%	0.33
6	q ID#[5]	17.84	5.15	0.71	29%	4%	0.10
7	q ID#[6]	46.94	13.53	1.88	29%	4%	0.42
8	q ID#[7]	49.09	14.16	1.96	29%	4%	0.92
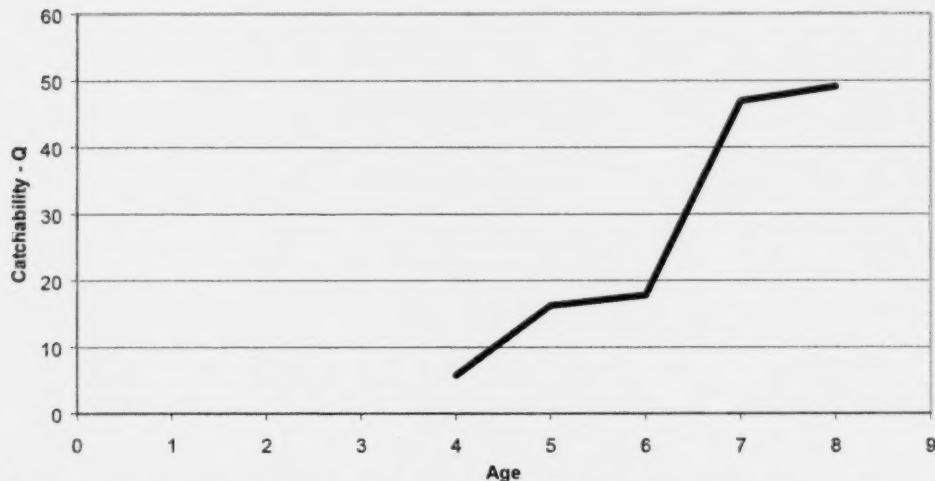
Figure 41. Parameter estimates and plot of catchability by age (Q) from VPA run with overall acoustic index for ages 4 to 8 only.
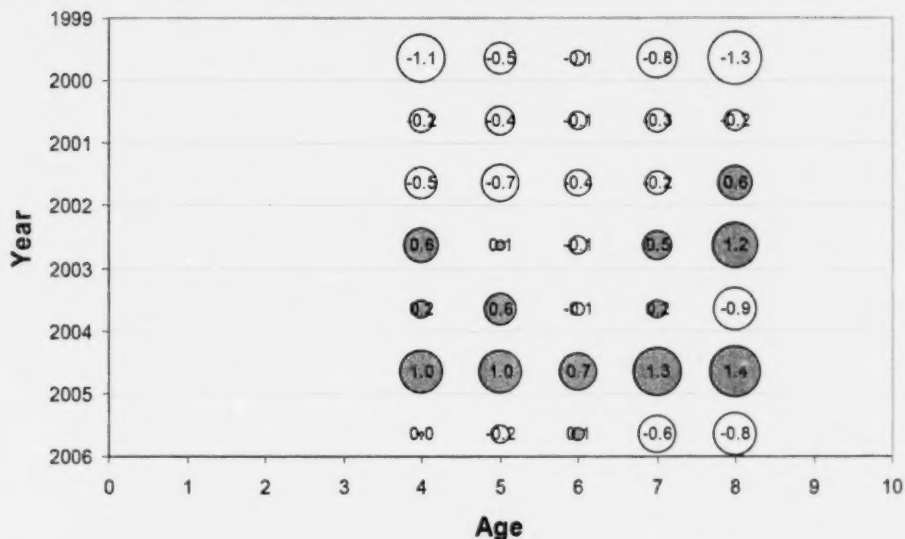
Figure 42. Residuals by age and year from a VPA run with the overall acoustic index for ages 4 to 8 only.
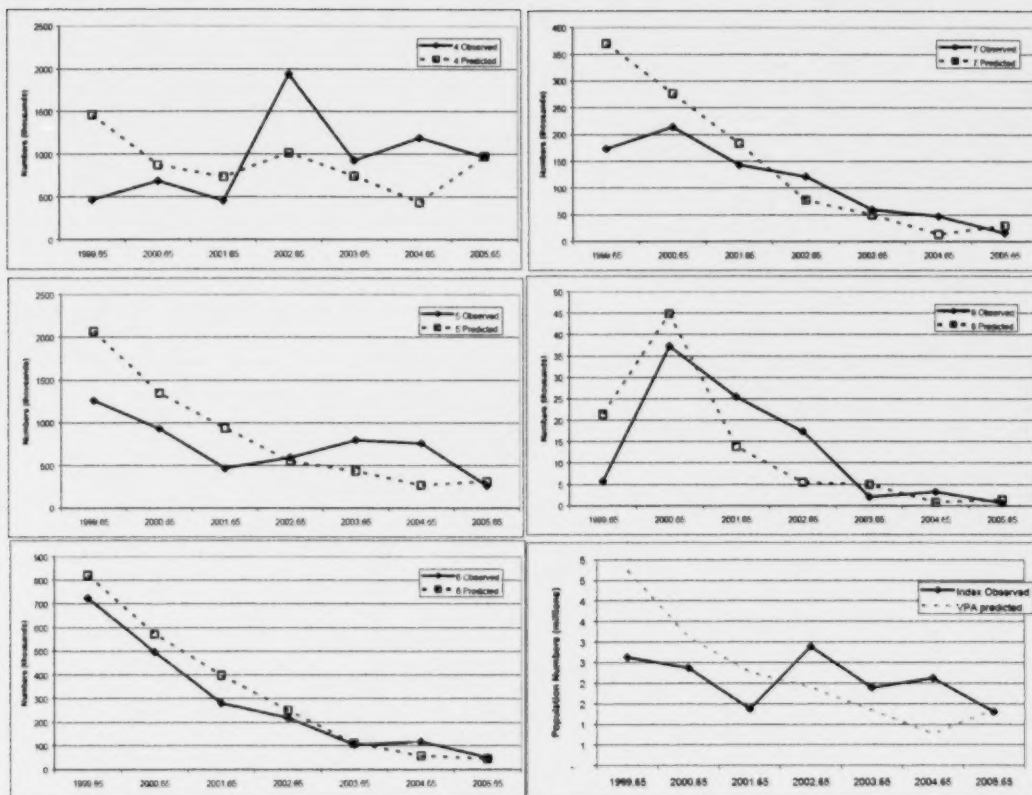
Figure 43. Age by age and overall combined plots of the observed abundance index and predicted population numbers versus year from VPA run with overall acoustic index for ages 4 to 8.

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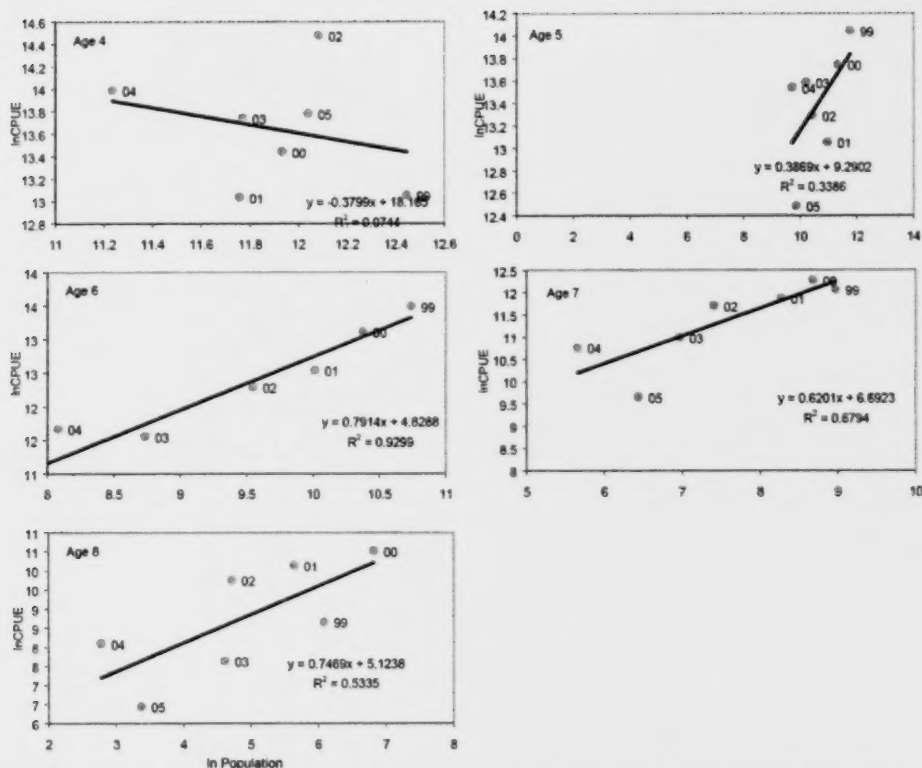
Figure 44. Age by age plots of the (ln) observed and (ln) predicted abundance index versus population numbers from a tuned VPA with the overall acoustic index for ages 4 to 8 treated as proportional to population numbers.
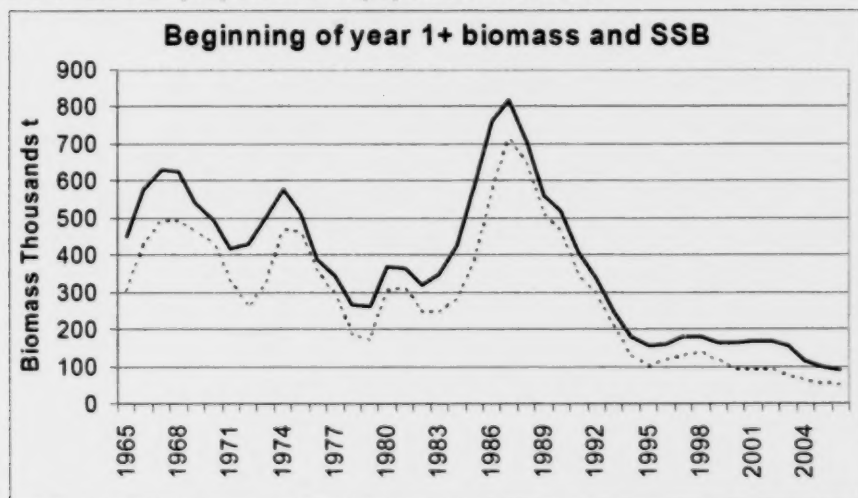
Figure 45. Spawning stock biomass and total biomass for VPA run with overall acoustic index for ages 4 to 8 (overall time series).
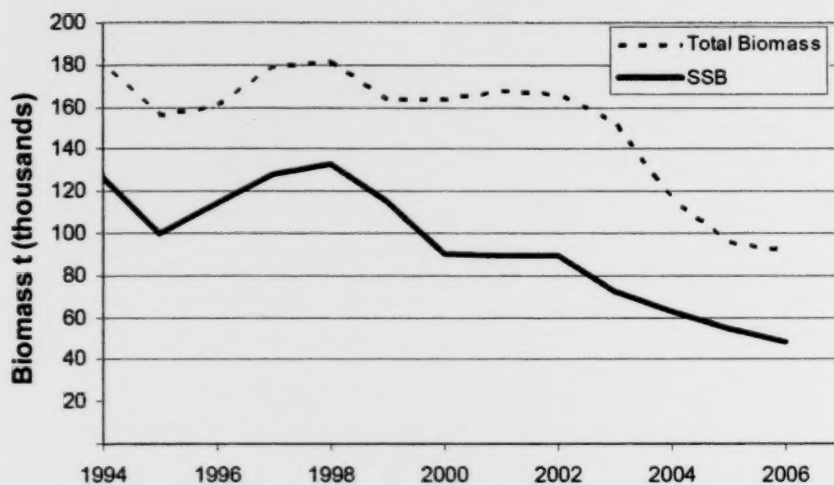
Figure 46. Spawning stock biomass and total biomass for VPA run with overall acoustic index for ages 4 to 8 (time period from 1994 to 2006)
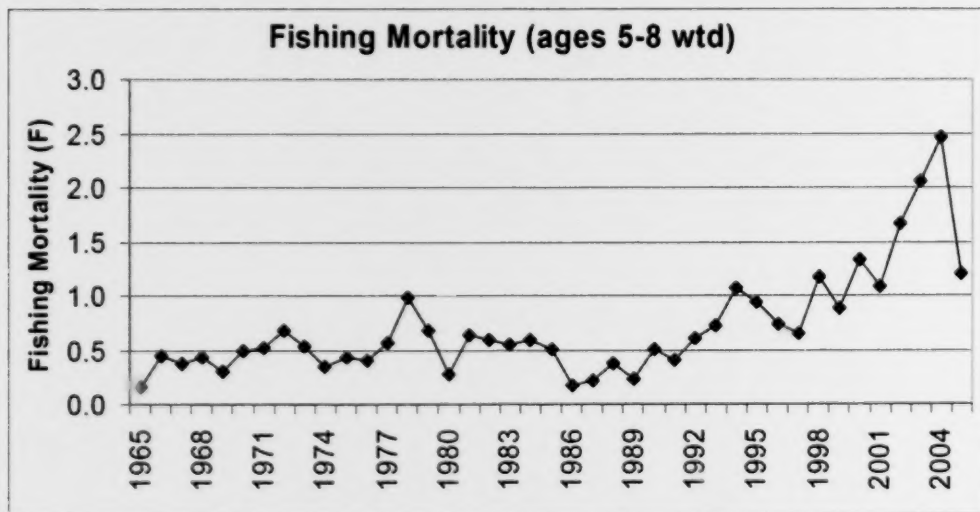
Figure 47. Fishing mortality for VPA run with overall acoustic index for ages 4 to 8
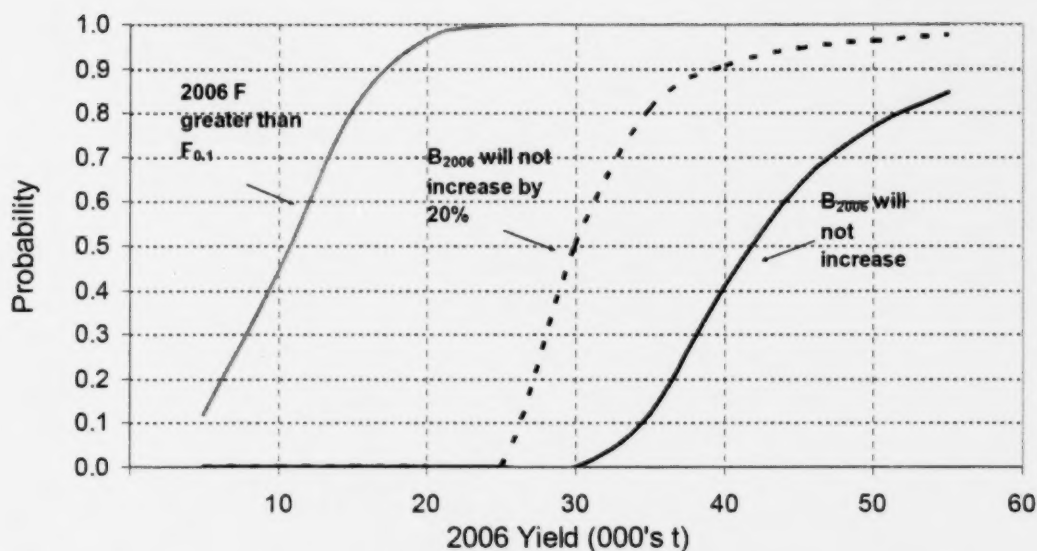
Figure 48. Probability (risk) of the 2006 fishing mortality exceeding F=0.228 and for 2007 total biomass being greater than the 2006 biomass by 0% and 20% at various yield (quota) levels for the VPA model with the overall acoustic index (ages 4 to 8).
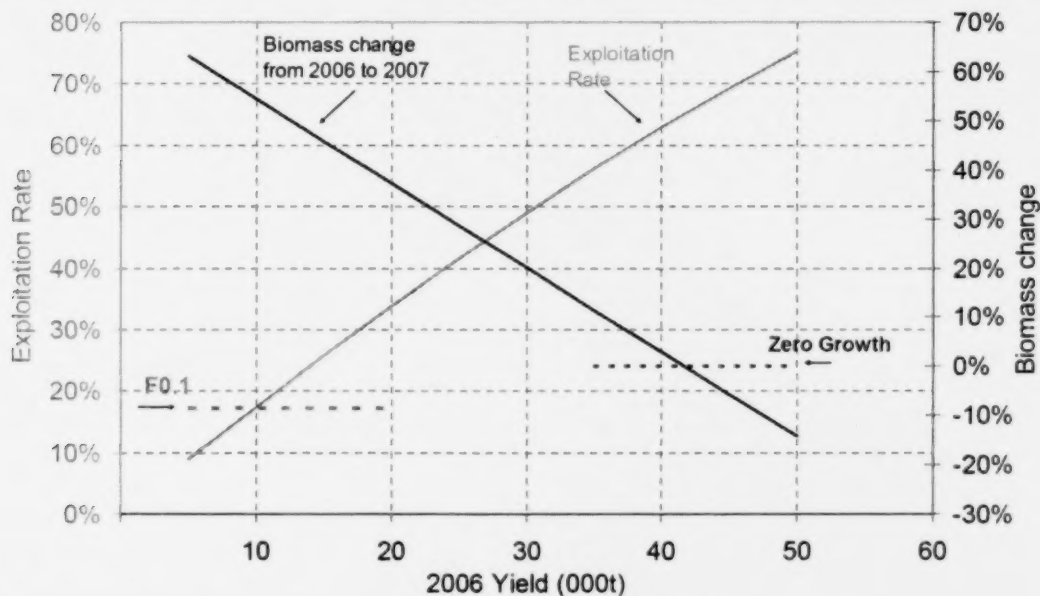
Figure 49. Exploitation rates (%) and total biomass change from 2006 to 2007 for various quotas (yield) in 2006 for the VPA model with the overall acoustic index (ages 4 to 8). The F0.1 reference level (F=0.228 or 17% exploitation) and zero growth levels are also indicated.

Age	Parameter	Estimate	Standard Error	Bias	%SE	% Bias	Avg Squared Residual
	N[2006 7]	2808.85	1322.78	265.55	47%	9%	0.59
4	q ID#[3]	3.76	1.13	0.16	30%	4%	0.46
5	q ID#[4]	10.39	3.12	0.44	30%	4%	0.46
6	q ID#[5]	11.84	3.55	0.51	30%	4%	0.20
7	q ID#[6]	30.92	9.27	1.34	30%	4%	0.46
8	q ID#[7]	34.55	10.37	1.50	30%	4%	0.87
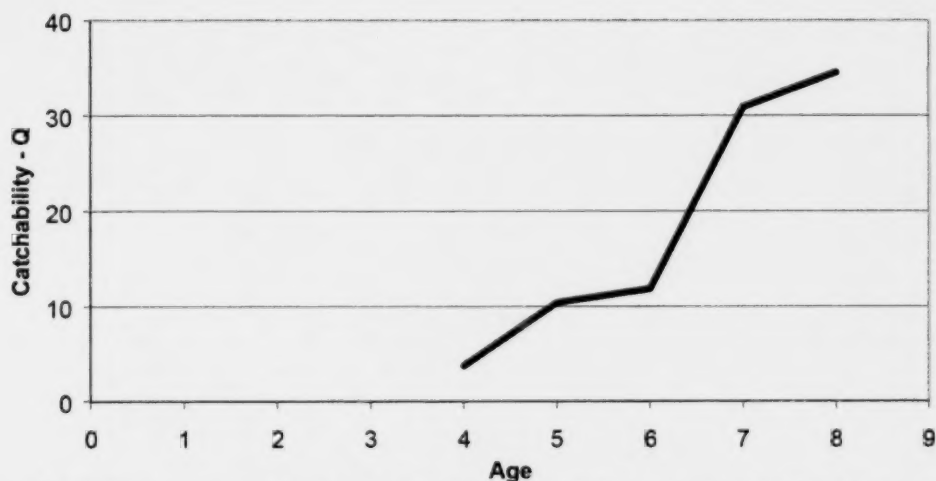
Figure 50. Parameter estimates and plot of catchability by age (Q) from VPA with German Bank acoustic index (ages 4 to 8).
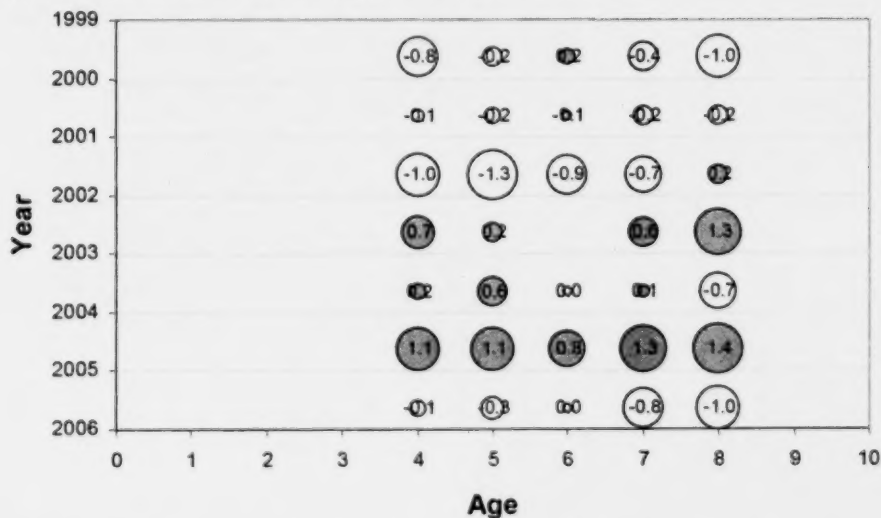
Figure 51. Residuals by age and year from a VPA run with the German Bank acoustic index (ages 4 to 8).

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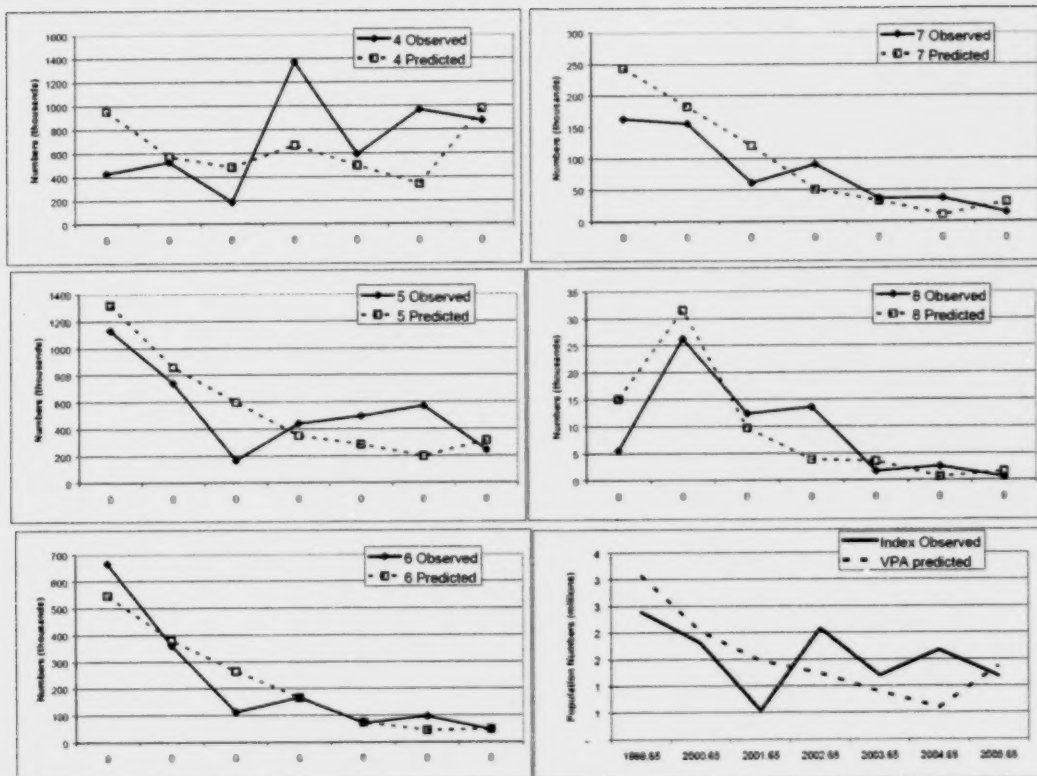
Figure 52. Age by age and overall combined plots of the observed abundance index and predicted population numbers versus year from VPA with German Bank acoustic index (ages 4 to 8).
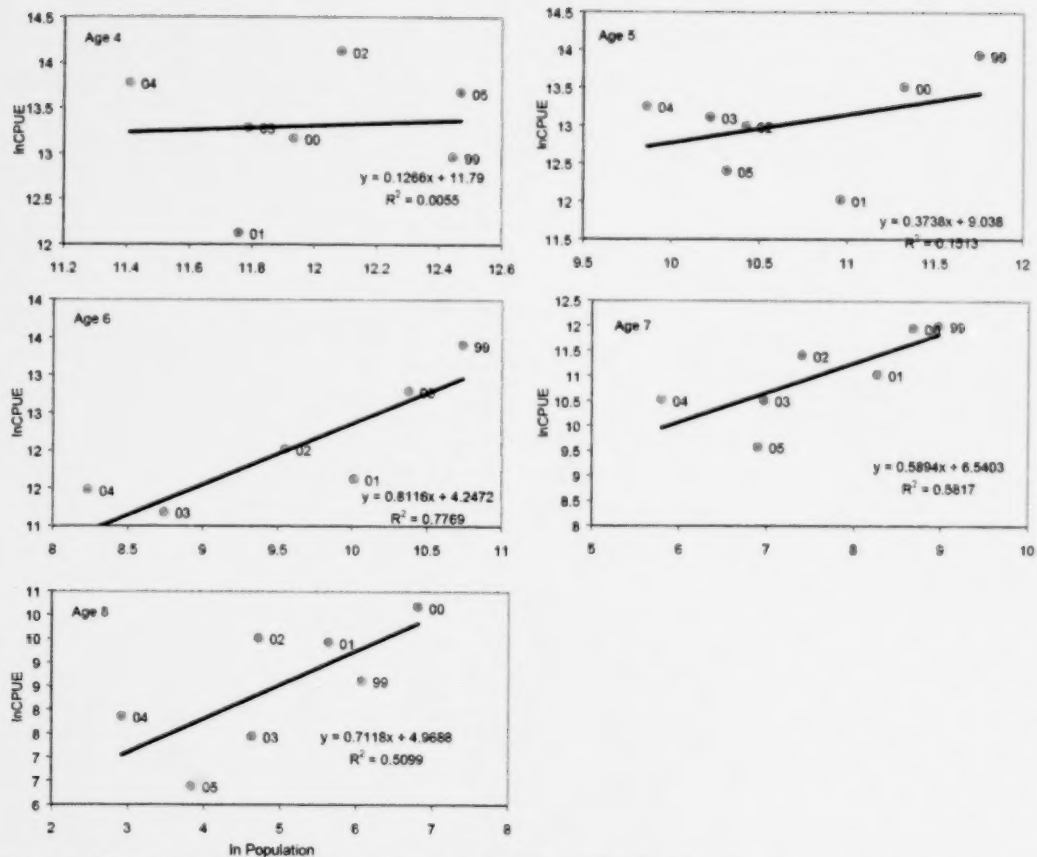
Figure 53. Age by age plots of the (ln) observed and (ln) predicted abundance index versus population numbers from a tuned VPA with the German Bank acoustic index (ages 4 to 8) treated as proportional to population numbers.
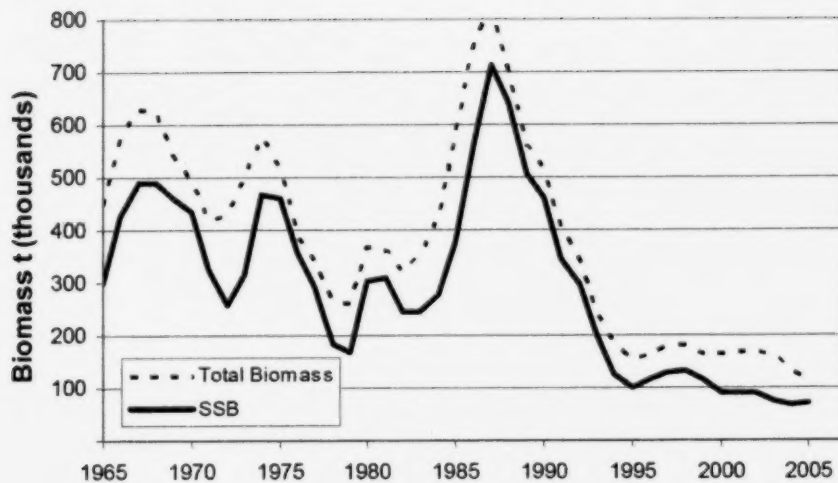
Figure 54. Spawning stock biomass and total biomass for VPA with German Bank acoustic index (ages 4 to 8).
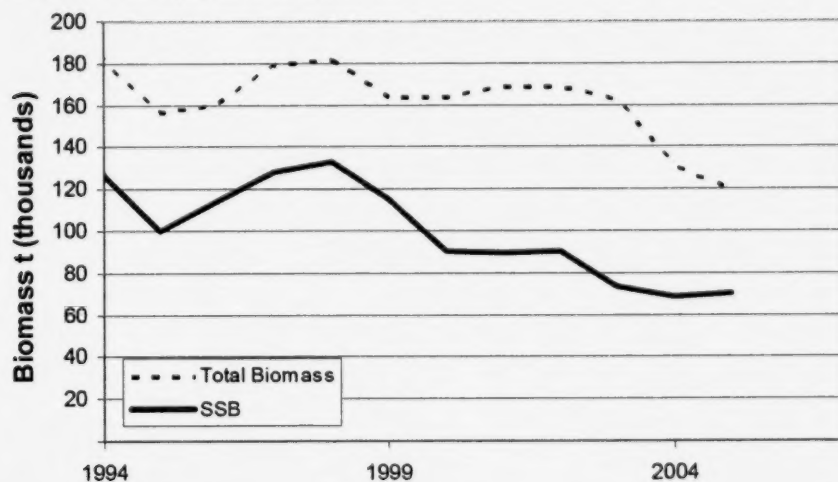
Figure 55. Spawning stock biomass and total biomass for VPA with German Bank acoustic index (ages 4 to 8) (time period from 1994 to 2005).
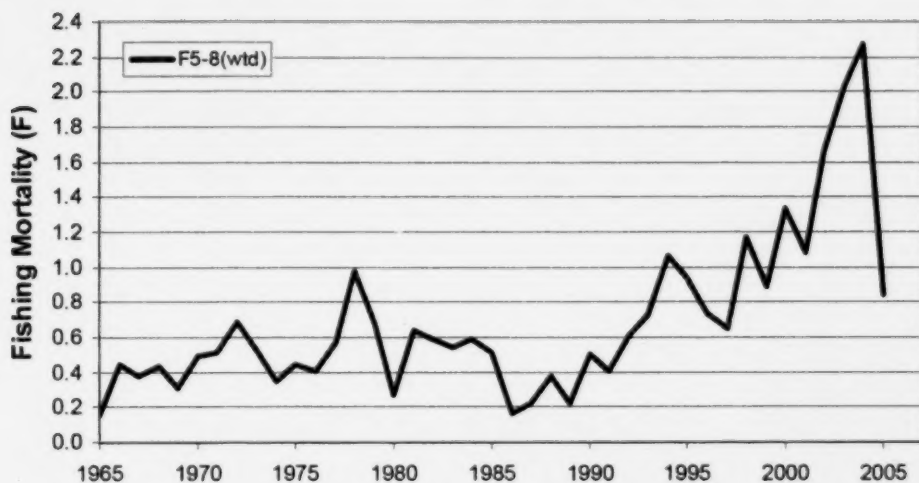
Figure 56. Fishing mortality for VPA with German Bank acoustic index (ages 4 to 8).
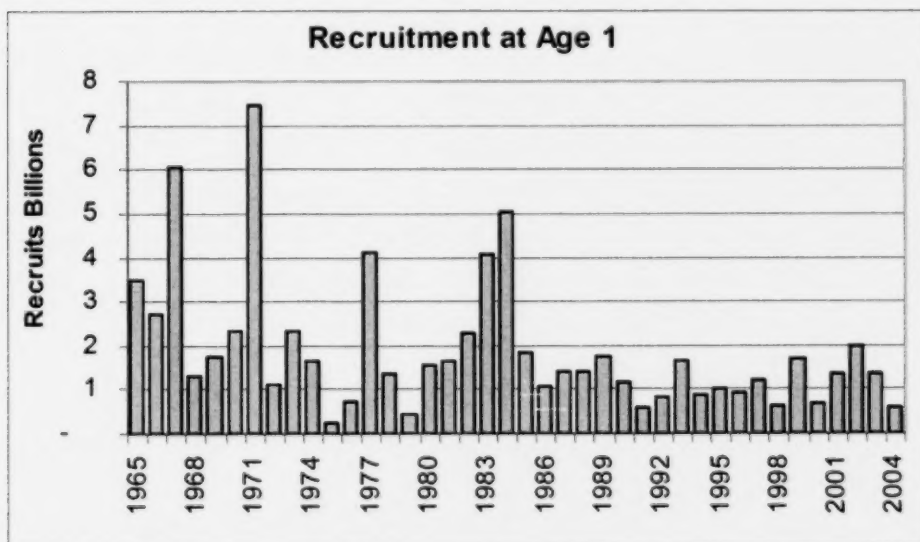
Figure 57. Recruitment at age 1 from VPA with German Bank acoustic index (ages 4 to 8).
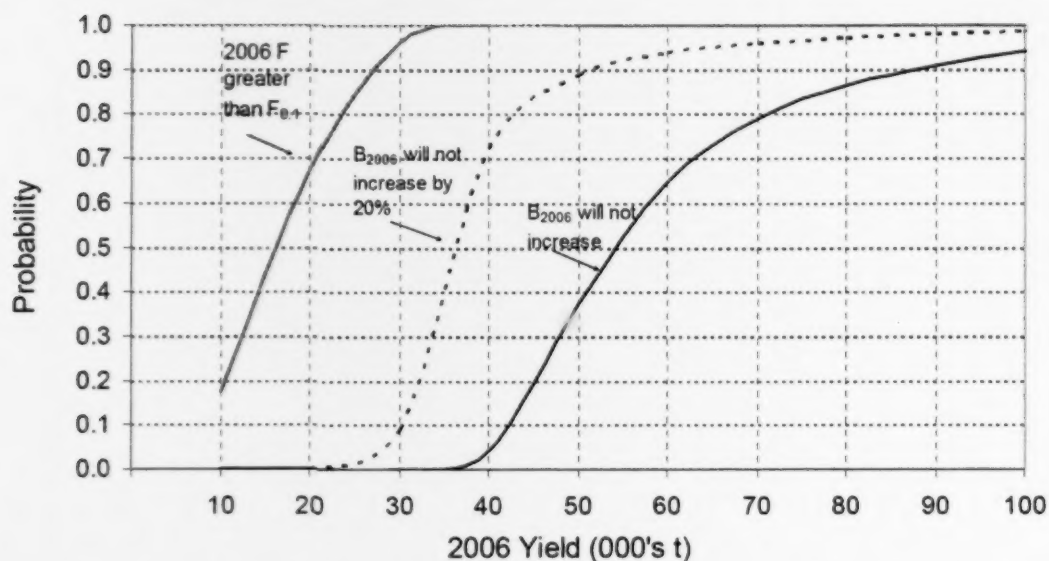
Figure 58. Probability (risk) of the 2006 fishing mortality exceeding F=0.228 and for 2007 total biomass being greater than the 2006 biomass by 0% and 20% at various yield (quota) levels for the VPA model with German Bank acoustic index (ages 4 to 8).
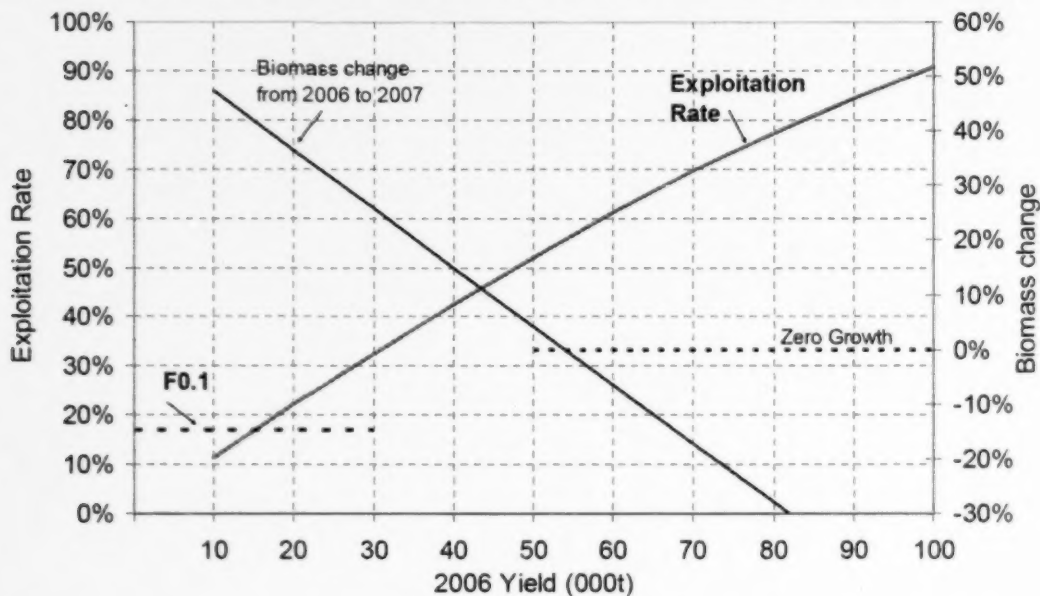
Figure 59. Exploitation rates (%) and total biomass change from 2006 to 2007 for various quotas (yield) in 2006 for the VPA model with German Bank acoustic index (ages 4 to 8). The F0.1 reference level (F=0.228 or 17% exploitation) and zero growth levels are also indicated.

Fishing Mortality (ages 5-8 wtd)

Beginning of year SSB

Recruitment at Age 1

Beginning of year 1+ biomass
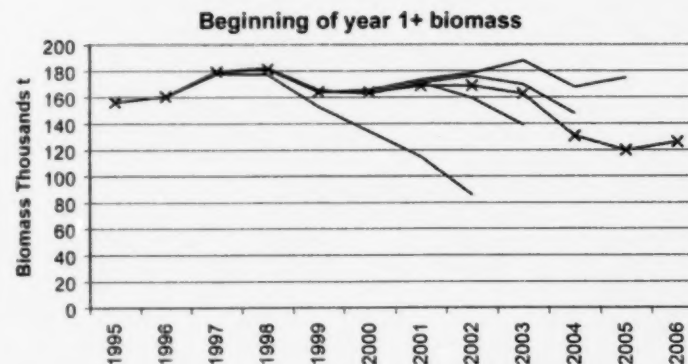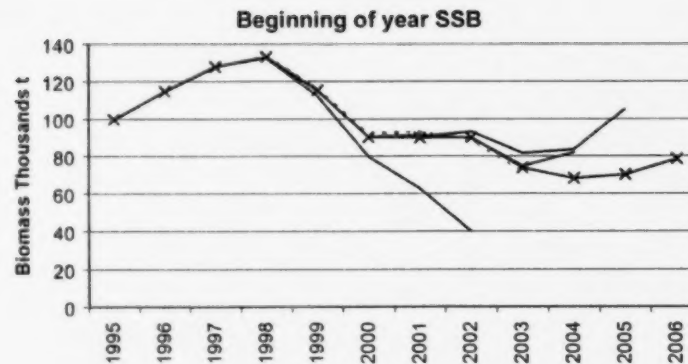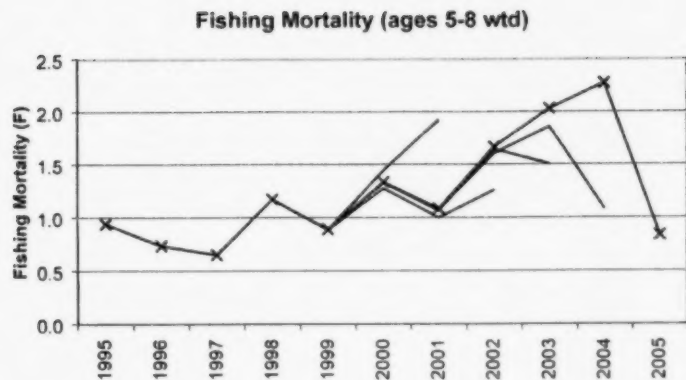
Figure 60. Retrospective analysis for VPA with German Bank acoustic index (ages 4 to 8) with successive years of analysis removed. Results for estimation of fishing mortality (F), recruitment at age 1, beginning of year SSB and beginning of year total biomass.

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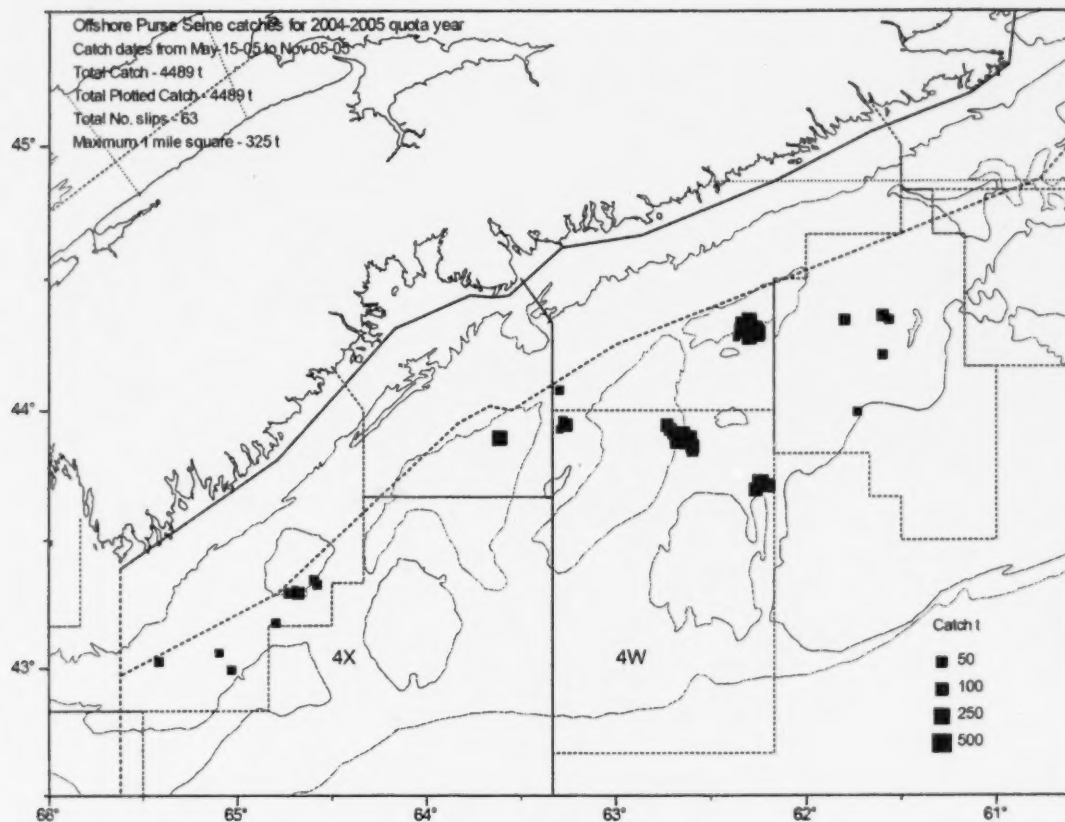
Figure 61. Herring purse seine catches on the offshore Scotian Shelf banks for 2005 with embayment and offshore 25 mile lines shown.
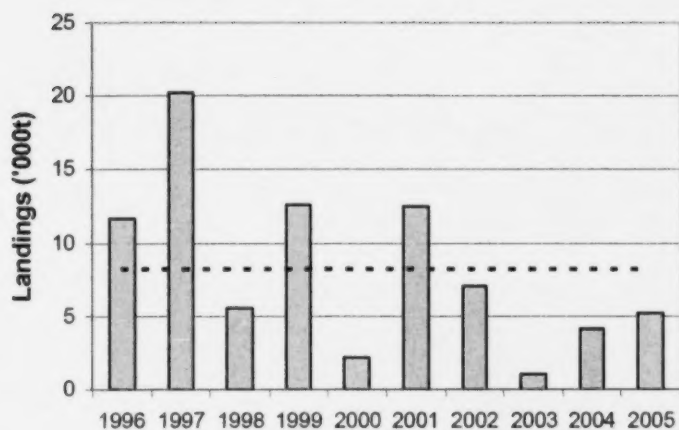
Figure 62. Scotian Shelf Banks landings from purse seine since 1996 with the average for the period.
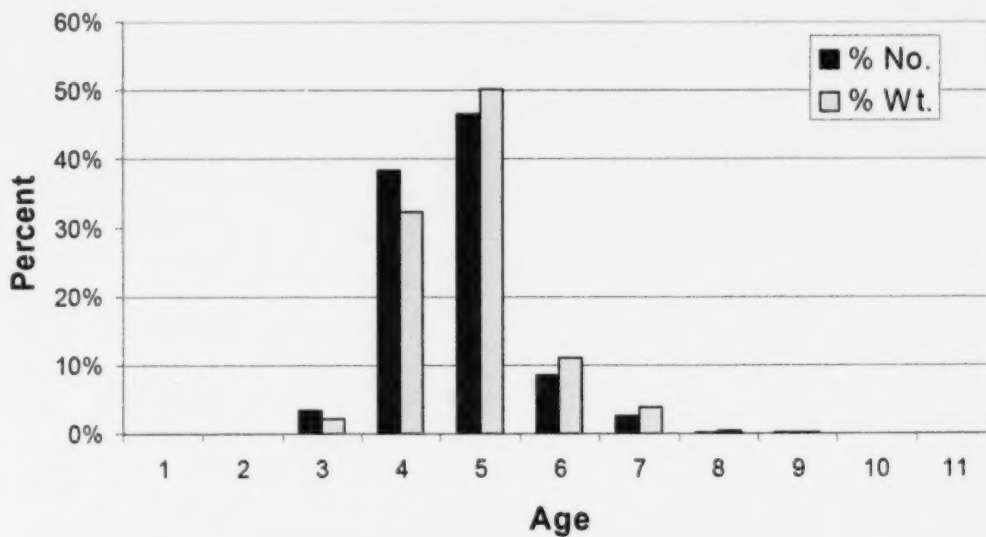
Figure 63. Catch at age for 2005 for the offshore Scotian Shelf banks purse seine fishery (% numbers and % weight).
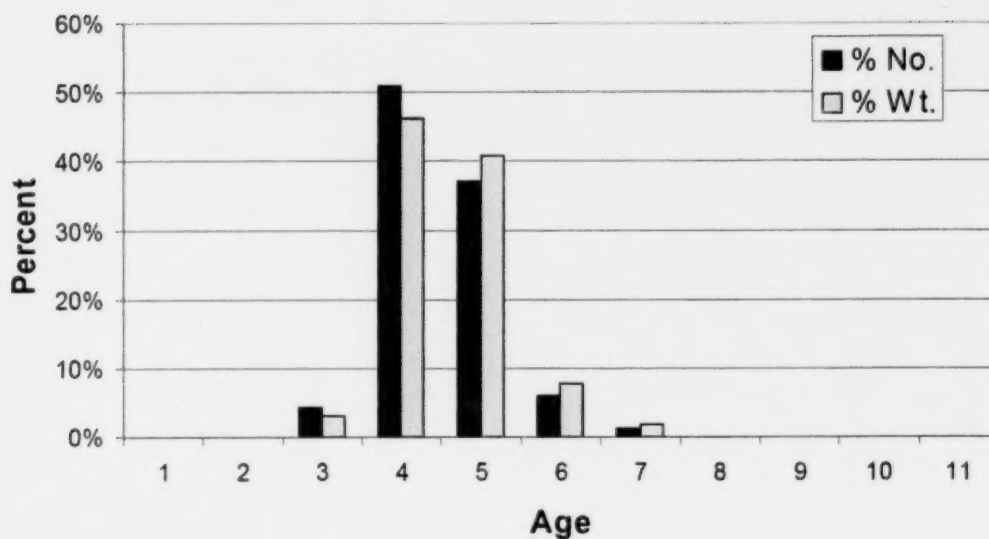
Figure 64. Catch at age for 2005 for the offshore Scotian Shelf banks midwater trawl fishery (% numbers and % weight).
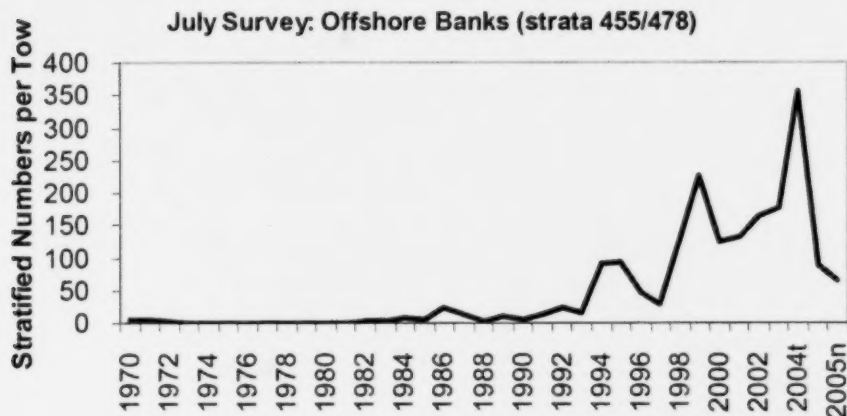
Figure 65. Number of herring caught per standard tow in the DFO summer bottom trawl survey of the offshore Scotian Shelf Banks, 1983 to 2005 (strata 55-78; from Sable Island to Baccaro Line).
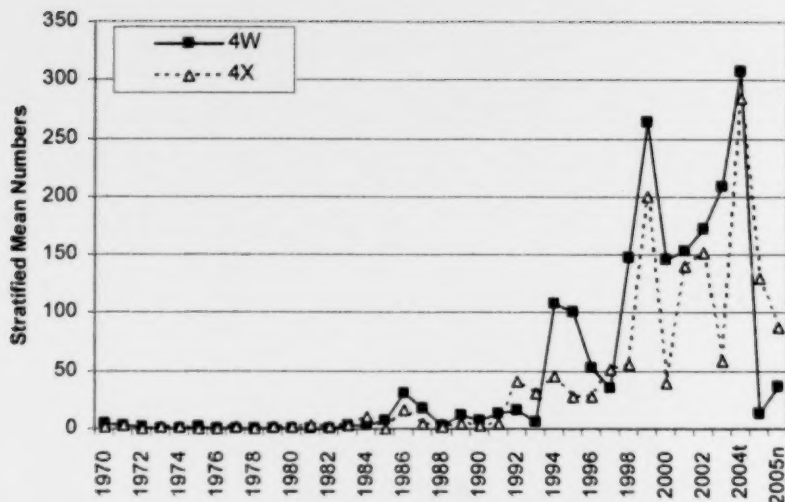
Figure 66. Number of herring caught per standard tow in the DFO summer bottom trawl research survey for 1970 to 2005 for area 4W (strata 53-66) and area 4X (strata 70-95).
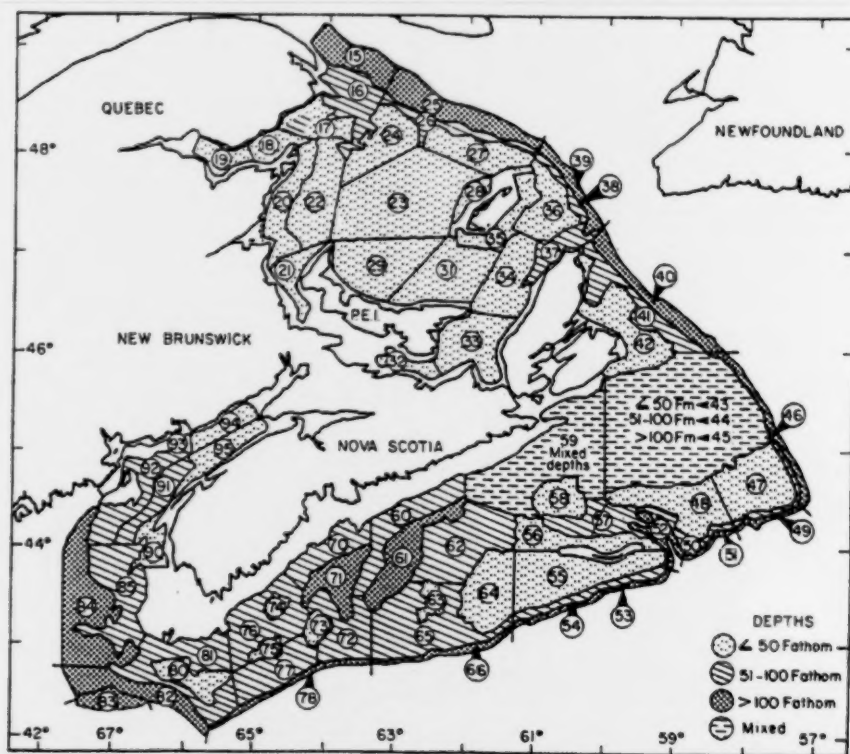
Figure 67. Research bottom trawl survey strata in NAFO Divisions 4T, 4V, 4W and 4X (from Doubleday, 1981).

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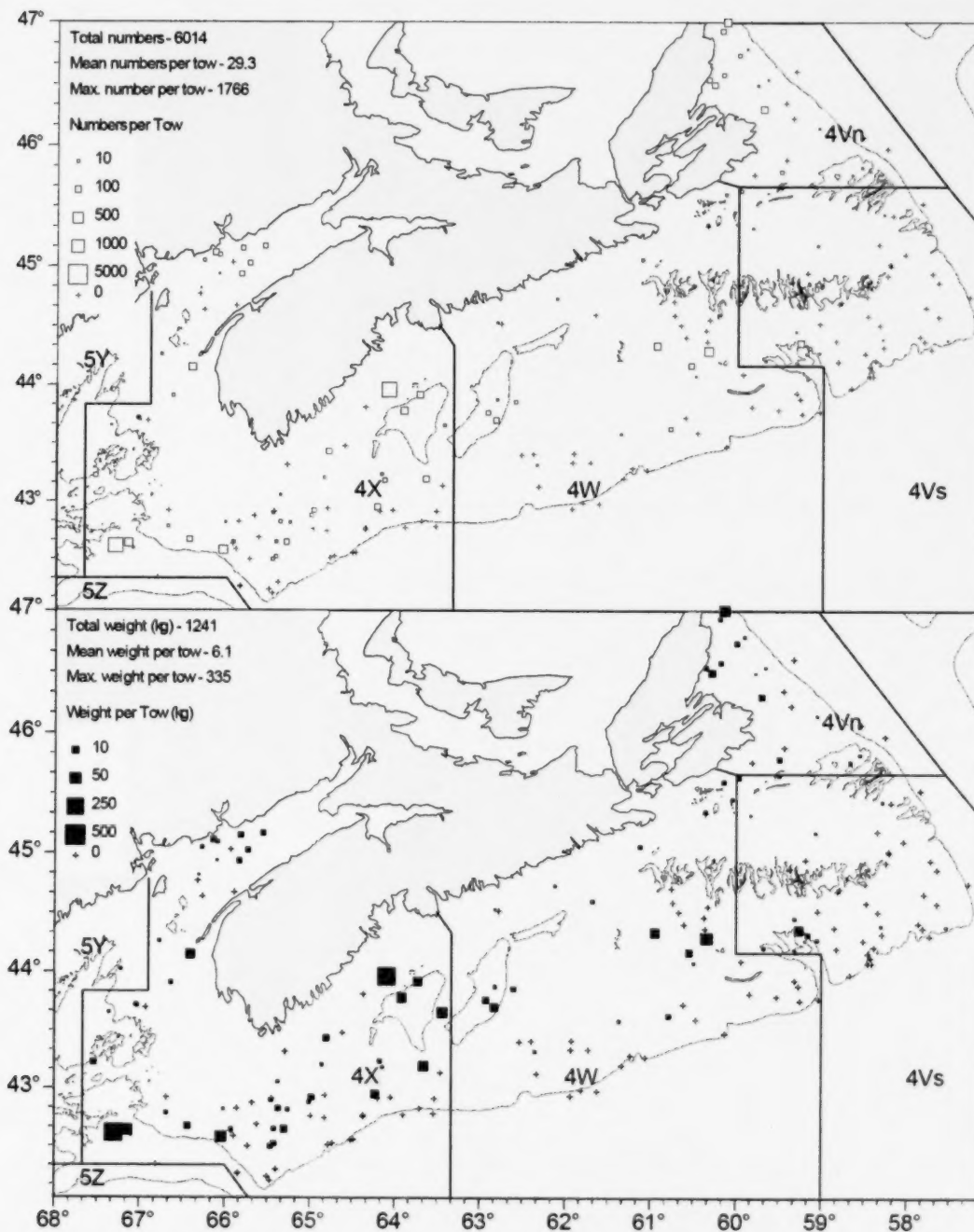
Figure 68. Herring catches in number and weight per tow for the 2005 DFO summer bottom trawl research survey (TEL2005-529/530: July 5-30, 2005).
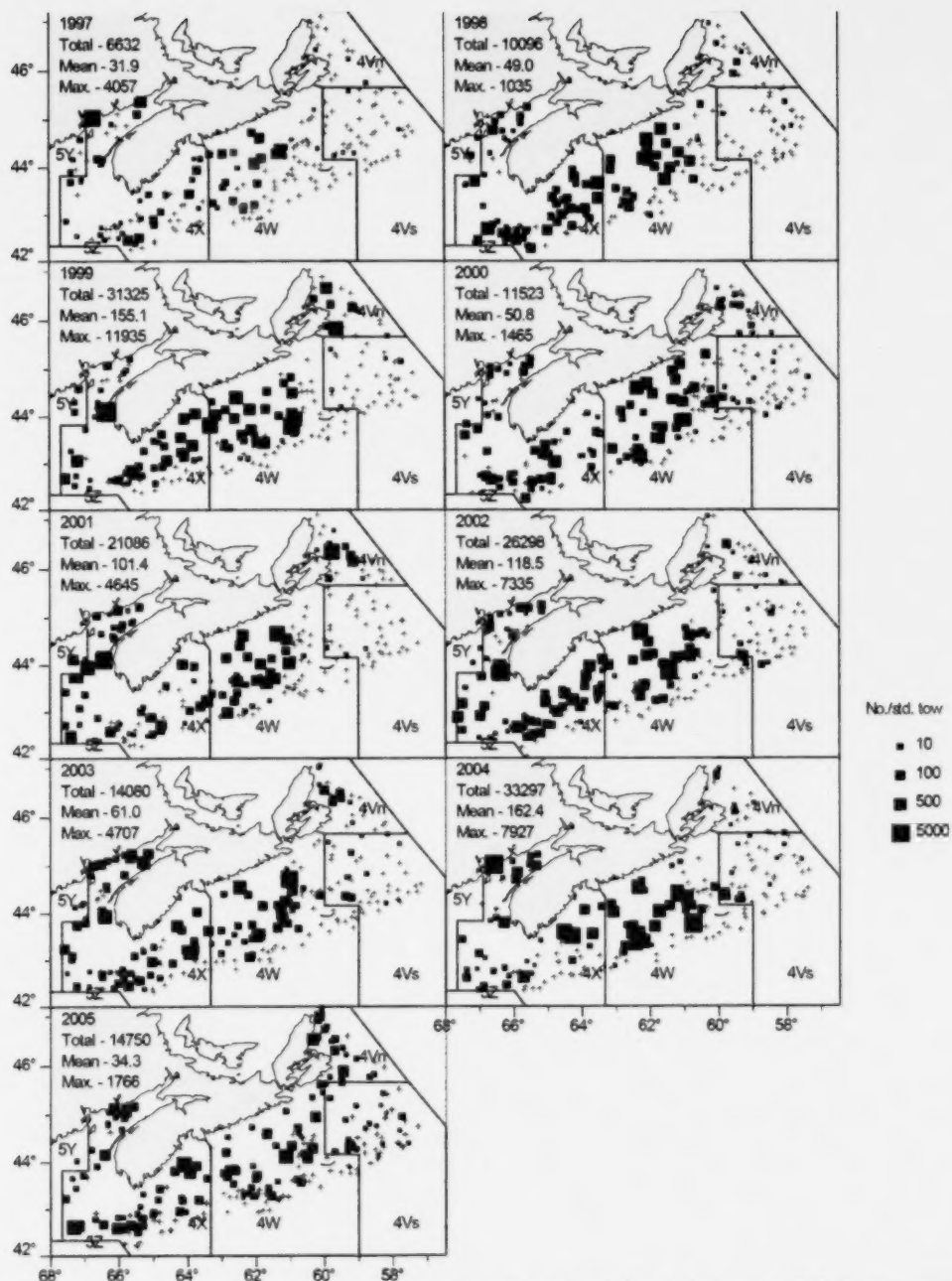
Figure 69. Herring catches (numbers per standard tow) from the DFO summer bottom trawl research survey for 1997-2005.
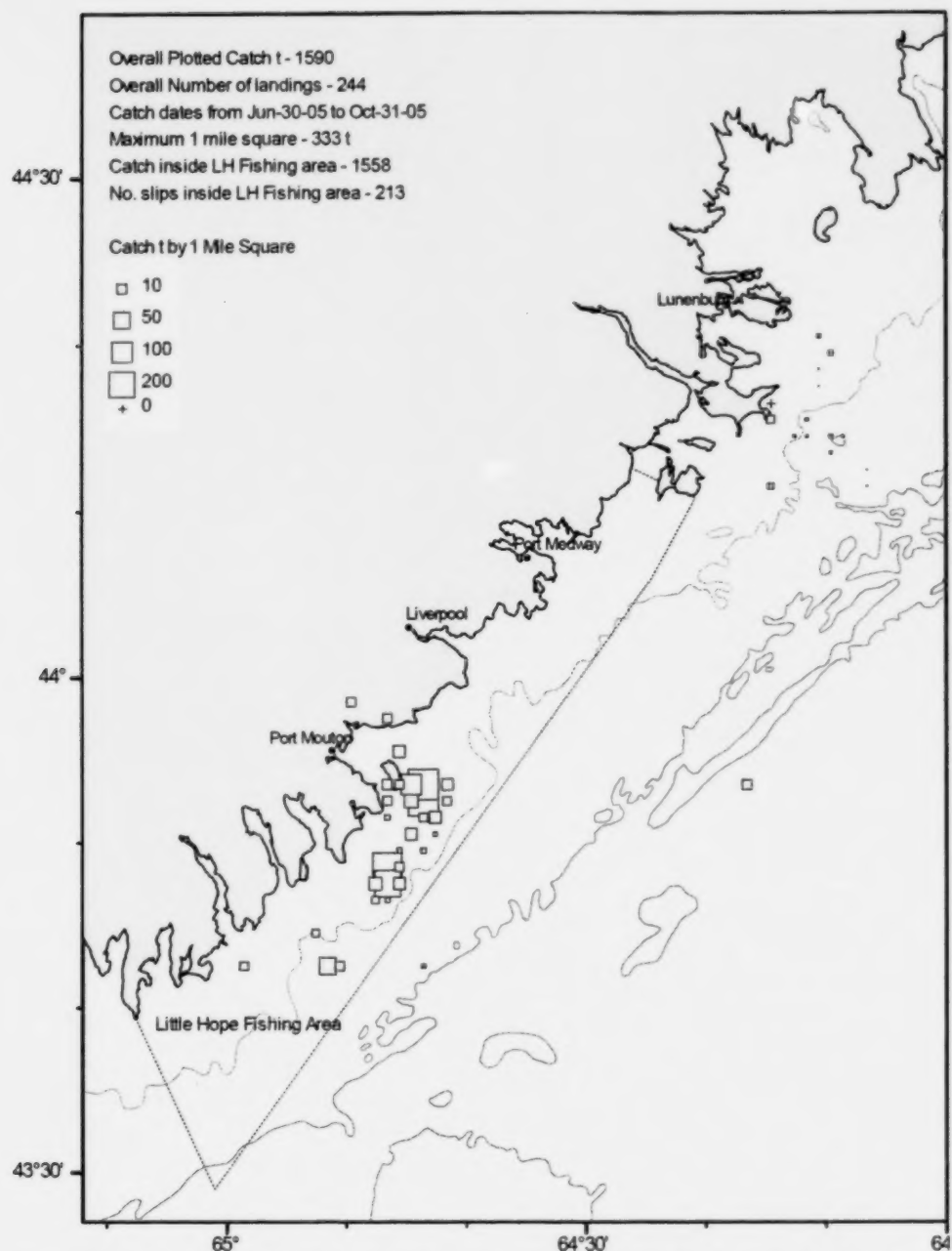
Figure 70. Little Hope/Port Mouton area herring gillnet catches for the 2005 spawning fishery. Overall landings and catches inside the Little Hope Fishing area are determined separately.

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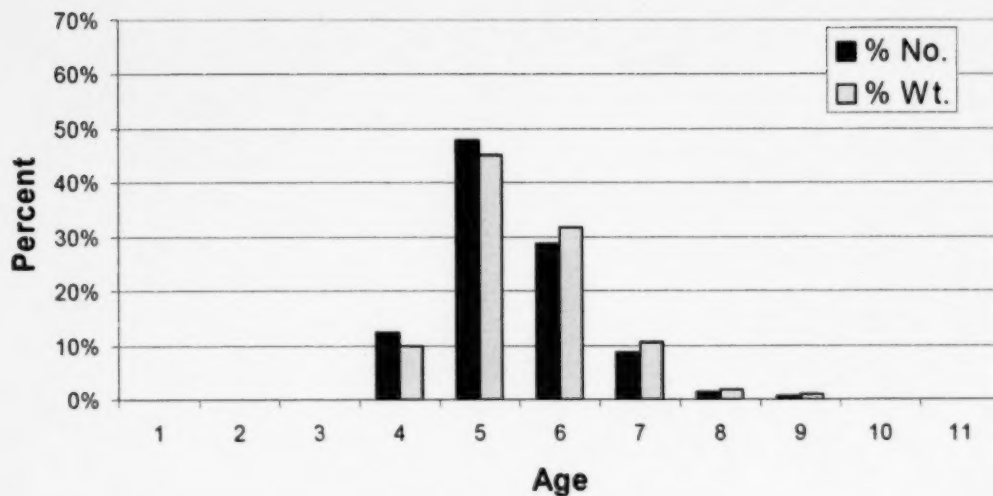
Figure 71. Catch at age (% numbers and % weight) of herring from the Little Hope/Port Mouton gillnet fishery in 2005. Note that the typical mesh size was 2 ½" for this fishery.
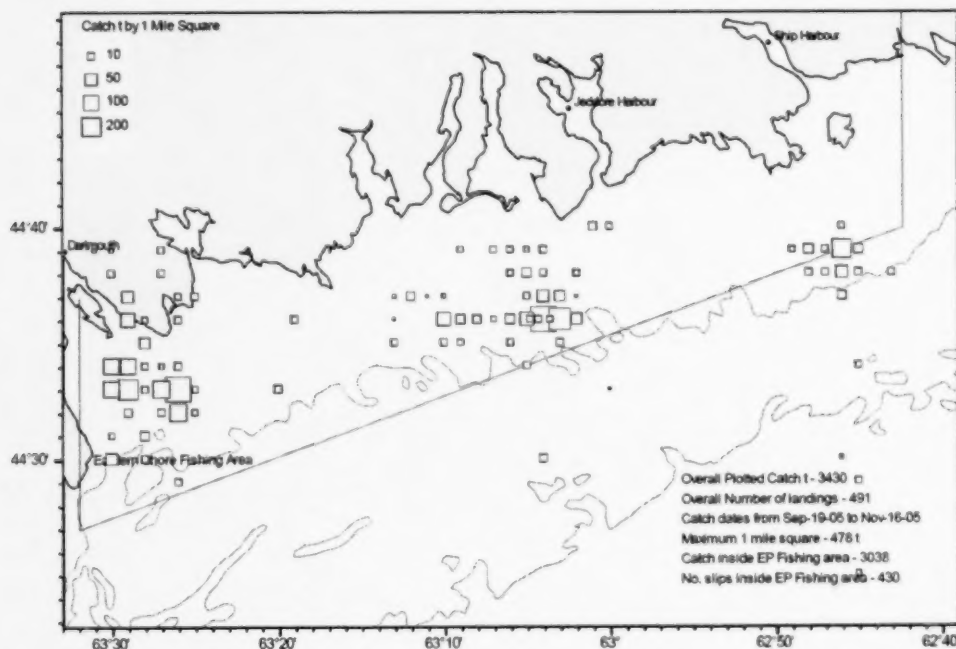
Figure 72. Eastern Shore/Halifax herring gillnet catches for the 2005 spawning fishery. Overall landings and catches inside the defined fishing area are determined separately.
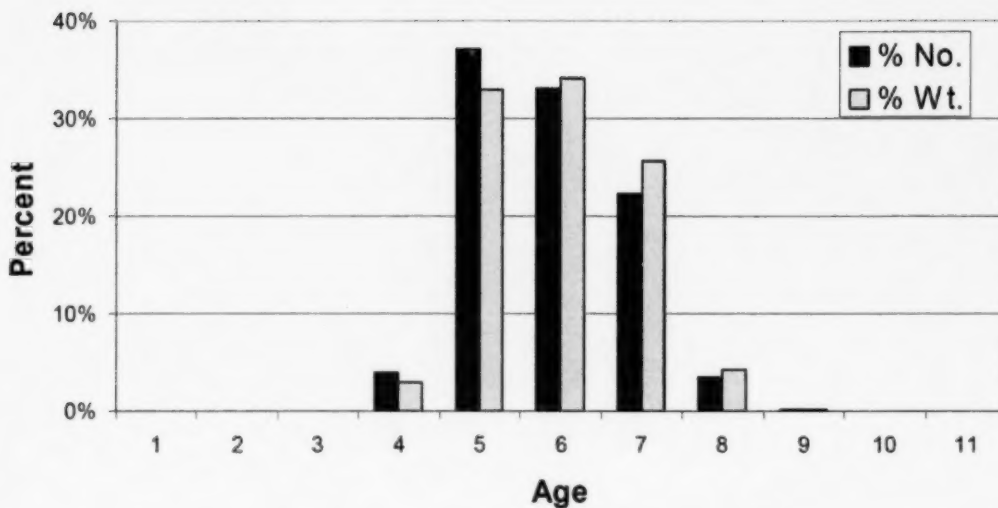
Figure 73. Herring catch at age (% numbers and % weight) for the 2005 Eastern Shore gillnet fishery. Note that the typical mesh size was 2 ¾" for this fishery.

Catch t by 1 Mile Square

- □ 10
- □ 50
- □ 100
- □ 200

Overall Plotted Catch t - 538
Overall Number of landings - 63
Catch dates from Sep-20-05 to Oct-08-05

Catch inside Red Grounds - 428
Catch inside Glace Bay Grounds - 8
Catch inside The Big Shoal - 0
Catch inside Fishing Grounds - 437

No. slips inside Red Grounds - 48
No. slips inside Glace Bay Grounds - 2
No. slips inside The Big Shoal - 0
No. slips inside Fishing Grounds - 50

Red Grounds

Glace Bay

The Big Shoal

Figure 74. Glace Bay herring gillnet catches (open squares) for the 2005 spawning fishery with catches inside each of the defined fishing areas determined separately.
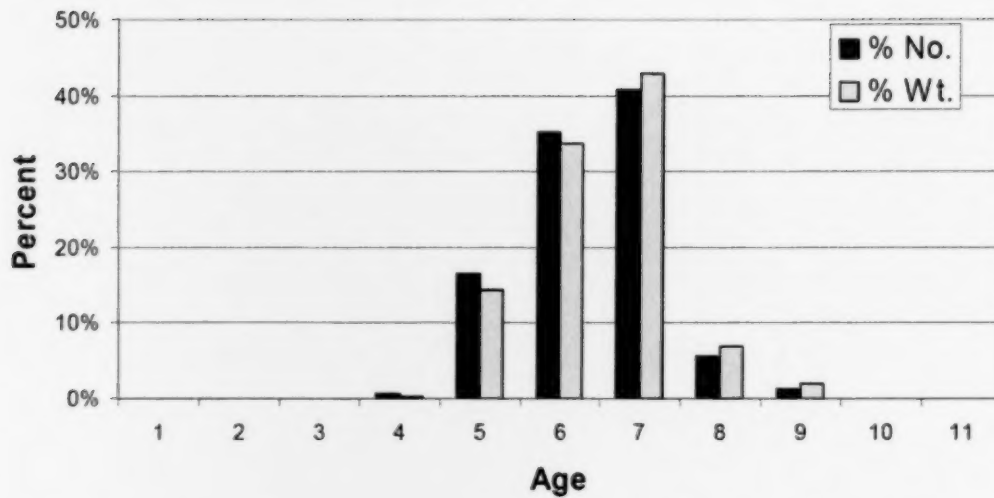
Figure 75. Herring catch at age (% numbers and % weight) for the 2005 Glace Bay gillnet fishery.
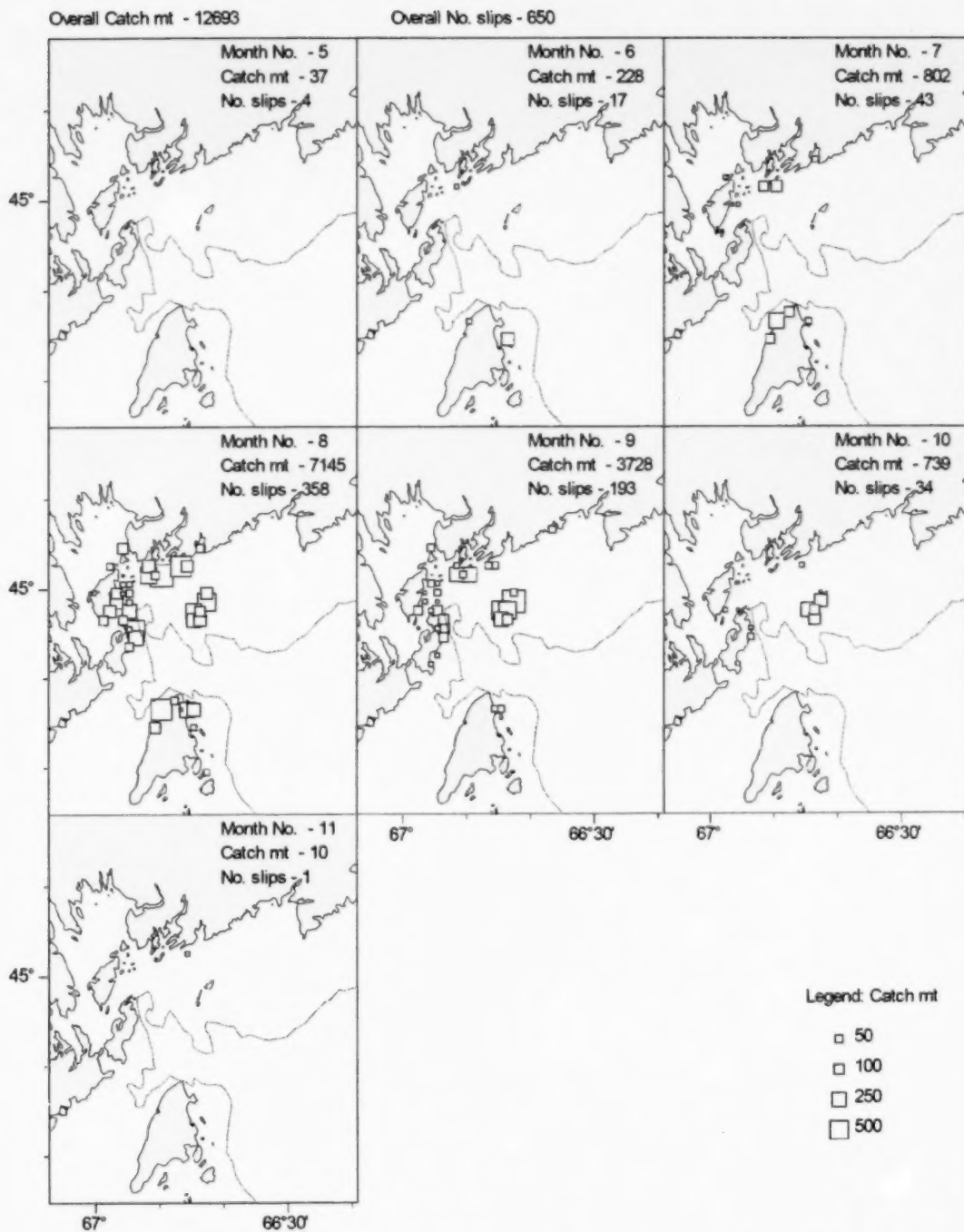
Figure 76. New Brunswick herring weir catches by month for the 2005 fishing season.
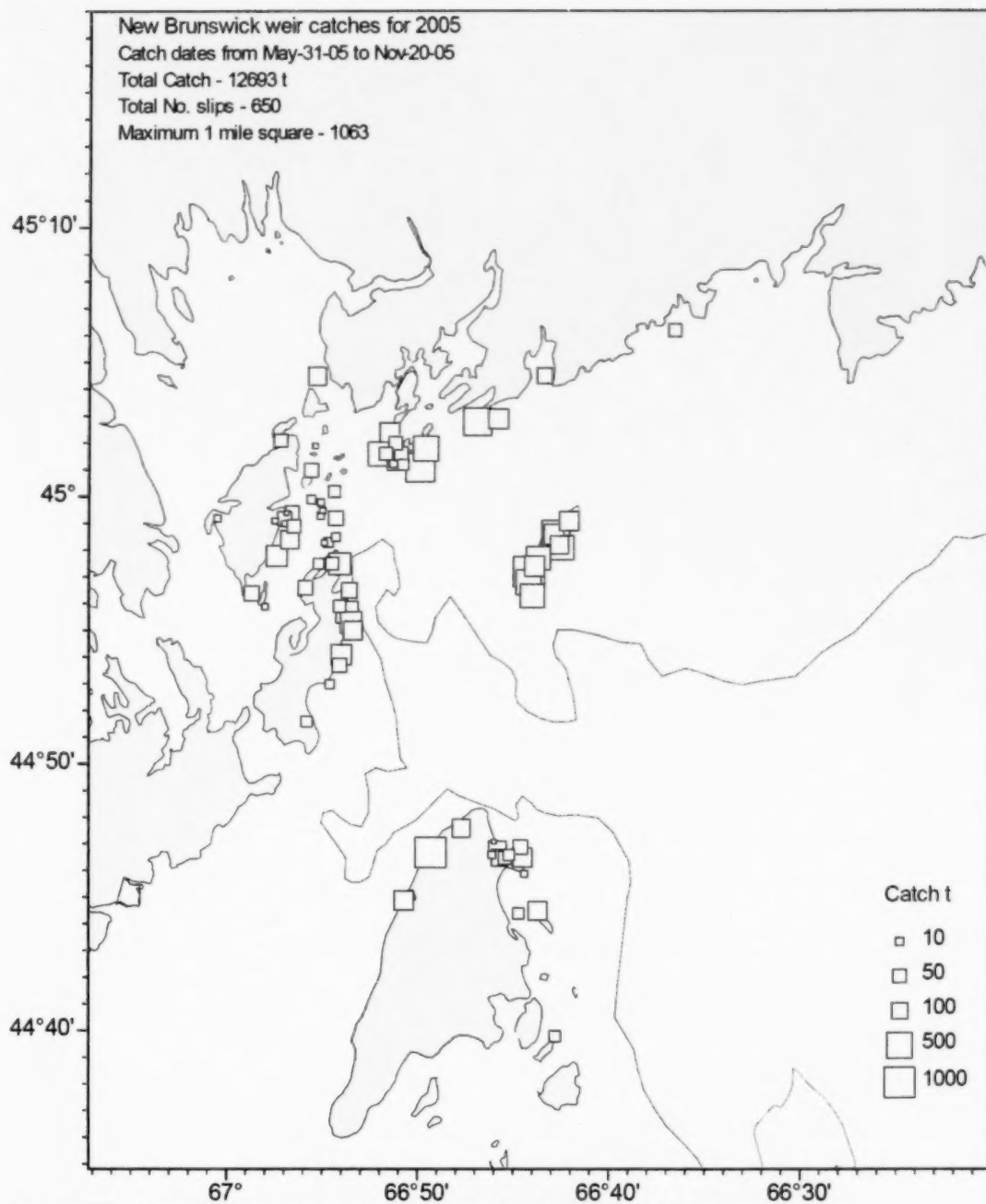
Figure 77. New Brunswick herring weir catches for the 2005 fishing season.
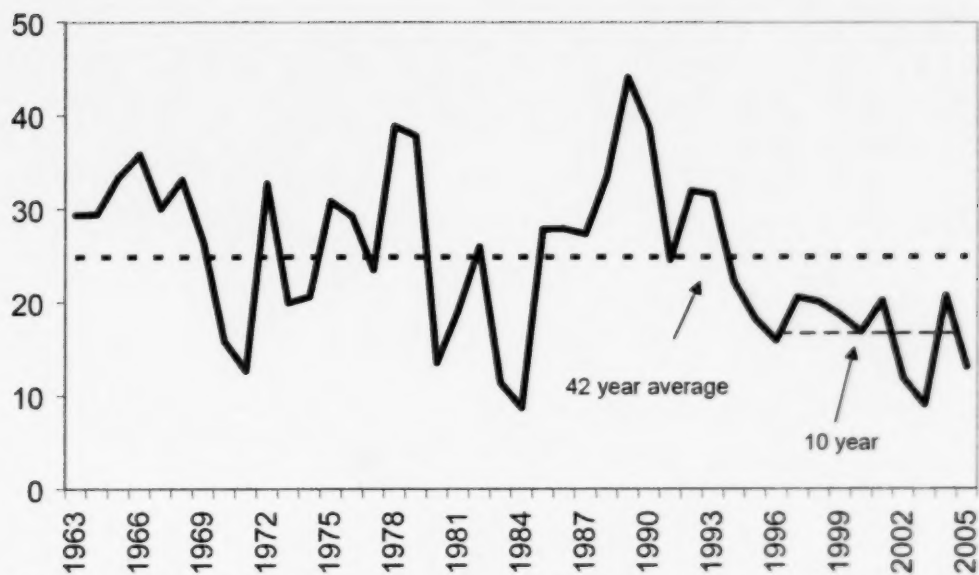
Figure 78. Herring landings from the southwest New Brunswick weir and shutoff fishery, 1963-2005 with overall time period average and recent 10 year average.
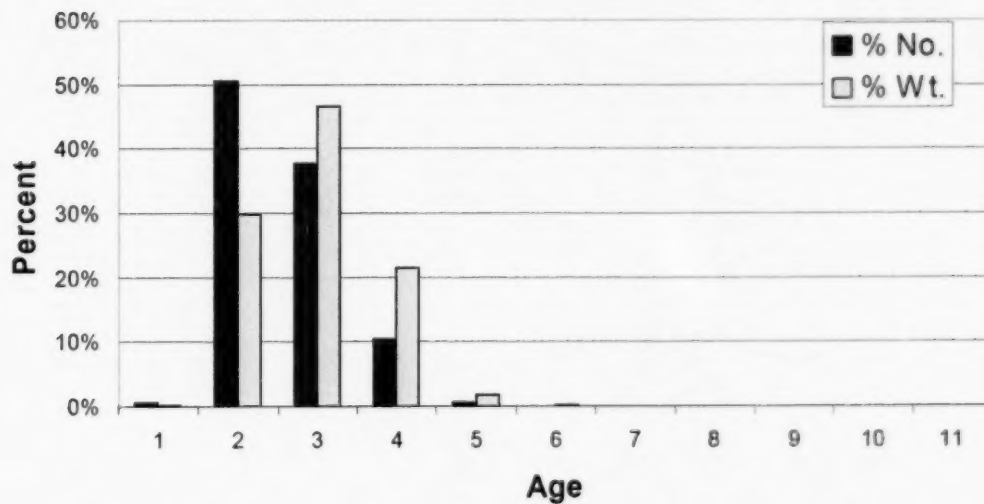
Figure 79. Catch at age (% numbers and % weight) of herring from the 2005 southwest New Brunswick weir and shutoff fisheries.

Appendix A. 2005 4WX Herring Fishery: Report of Fleet Activity.

2005 4WX Herring Fishery: Report of Fleet Activity

Herring Science Council
P.O. Box 517, Yarmouth, NS, B5A 4B4

The herring industry in association with the Herring Science Council provides an annual summary of seiner fleet activity throughout the fishing season. This gives a general overview of the activities of the purse seine fleet and highlights important anecdotal information that may otherwise be lost. Information was gathered through association records, captain's reports and comments, through HSC and DFO staff, and thought DFO landings and samples databases. The following is a summary of the activities for the 2004-2005 quota year purse seine fisheries. Please refer to Tables 1-2, and Figures 1-2 to see a graphic organization of the landings per week and length of fish per week.

Offshore/ Scotian Shelf Banks

Summary

- Reactivated fishing area since 1996
- The 2005 Offshore/Scotian Shelf purse seine fishery took place on Weeks 20, 22, 23, 24, 25, 26, and 29.
- A grand total of 4,358 t of herring was caught on the offshore banks, which was similar to 2004 with 4,054 t caught.
- Weather was described as poor for the majority of the 2005 Offshore/Scotian Shelf fishery.

Week 20: May 15- May 21
15 T was landed at Western Hole (1 landing), and 515 T was landed on the Offshore Banks (9 landings). The average fish length on the Offshore Banks was 29.2 cm.

Week 22: May 29- June 4
20T (1 landing) of herring was caught at Western Hole.

Week 23: June 5- June 11
392T was landed on the Offshore Banks (3 landings) with an average fish length of 28.2 cm, 29T at Shelburne with an average fish length of 26.0, and 153T at Western Hole (5 landings) with an average fish length of 27.2 cm.

Week 24: June 12- June 18
760T (7 landings) was landed on the Offshore Banks with fish averaging a length of 29.0cm.

Week 25: June 19- June 25
812T (11 landings) was landed on the Offshore Banks this week, with average length of herring being 28.7 cm.

Week 26: June 26 – July 2
Much of the seining fleet was fishing off Halifax this week. 1581T (16 landings) of herring was landed from the Offshore Banks with fish averaging 29.2 cm in length.

Week 29: July 17- July 23
26 T (1 landing) was landed from Western Hole.

South West Nova Scotia Component

The quota year for South West Nova is from the period October 15 to the following October 14, and so catches from October 15 to December 31, 2004 are included in the quota total. The 2005-year fishing weeks are summarized separately below.

Appendix A. 2005 4WX Herring Fishery: Report of Fleet Activity.

Summary

- The purse seine fleet concentrated their efforts on pre-spawning aggregations mainly on the Long Island Shore, the Grand Manan Banks, Gannett Dry Ledge, and Lurcher.
- Spawning aggregations were targeted on German Bank and Scots Bay.
- Weeks 1-3 showed activity in NB Coastal and the Grand Manan Banks.
- Fishing started at about the same time as last year in the spring at week 19: May 9-May 15, compared to 2003 when they started in Week 18: April 27- May 3, and 2002 when the fishery started at Week 16: April 13-19.
- The weather varied across the season with good weather and poor weather throughout.
- In May about 68% of landings came from the Gannet Dry Ledge, June the majority of landings were from Long Island Shore at 83%, July the greatest was 33% from the Grand Manan Banks. In August 51% of the landings came from Scots Bay. September the majority was from German Bank at 59% with landings from Scots Bay at 3%. The month of October had 60% of landings were from the German Bank.

2004 Fishing Weeks

Week 42: October 17- October 23
One landing was made on Gannett Dry Ledge of 22 T. 132 T was caught on the Grand Manan Banks from 6 landings. 78T (2 landings) was landed on the Long Island Shore, and 515 T (24 landings) in NB Coastal.

Week 43: October 24- October 30
27 T was landed from the Grand Manan Banks in 2 landings. 562T was landed from NB Coastal in 20 landings.

Week 44: October 31- November 6
45 T (1 landing) of herring was caught on the Grand Manan Banks, and 361T (9 landings) was landed from NB Coastal this week.

Week 45: November 7- November 13
3 landings were made from NB Coastal (116 T) and 6 landings were made from the Grand Manan Banks (175T) this week.

2005 Fishing Weeks

Week 1: January 2- January 8
Landings were made this week on the Grand Manan Banks and NB Coastal. 15 T (1 landing) was landed on the Grand Manan Banks, and 161 T (6 landings) was landed in NB Coastal. The average fish length in NB Coastal was 16.9cm.

Week 2: January 9- January 15
This week 7 landings were made in NB Coastal totalling in 175Tm with herring length averaging 15.0cm.

Week 3: January 16- January 22
5 landings were made this week in NB Coastal totaling in 220T of herring landed.

Week 19: May 8- May 14
2 landings were made in Trinity (23T) and 1 in Lurcher (17T) this week.

Week 20: May 15- May 21
262 T was landed from Gannet Dry Ledge (10 landings) with an average fish length of 22.1cm, 39T was caught on German Bank (4 landings), 30 T was landed on Lurcher Shoal (3 landings) with an average fish length of 22.5cm, and 13 T was caught in Trinity (1 landing).

Appendix A. 2005 4WX Herring Fishery: Report of Fleet Activity.

Week 22: May 29- June 4
62 T was caught from 3 landings at Gannet Dry Ledge having the average fish length at 26.6cm, 12 T (1 landing) from the Grand Manan Banks with an average fish length of 22.5cm, 1,189 T (29 landings) from the Long Island Shore with fish length averaging 21.9cm, and 37 T (1 landing) from Lurcher Shoal with fish lengths at an average of 26.5cm.

Week 23: June 5- June 11
628 T from 17 landings were made at Long Island Shore, 15T from 1 landing was seined on Gannet Dry Ledge. The average fish length at the Long Island Shore was 22.9cm.

Week 24: June 12- June 18
437 T (10 landings) was landed from the Grand Manan Banks, 91 T (2 landings) from the Long Island Shore and 16 T (1 landing) from German bank this week. The average fish length on the Grand Manan Banks was 26.0cm, and the average fish length on the Long Island Shore was 24.5cm.

Week 25: June 19- June 25
89T was caught on the Grand Manan Banks from 3 landings, and 686 T was landed from the Long Island Shore from 21 landings this week. The average fish length on the Grand Manan Banks was 26.5cm, and on the Long Island Shore was 23.5cm.

Week 26: June 26- July 2
The fleet was split this week with about half of the seiners fishing in SWN. 621T was procured from the Longs Island Shore this week from 15 landings. Average fish length on the Long Island Shore was 25.2 cm.

Week 27: July 3- July 9
This week the fleet had returned to fishing the area off SW Nova Scotia. 432 T (7 landings) was caught on Gannet Dry Ledge average fish length 25.3cm, 946 T (25 landings) of herring was obtained from the Grand Manan Banks this week average fish length of 24.3cm, 1,268 T (18 landings) were caught on German Bank average fish length 25.7 cm, 293 T (10 landings) caught on the Long Island Shore average fish length 24.2cm, 963 T (14 landings) from the SW Grounds average fish length 25.7cm, and 69 T from 1 landing on Seal Island with an average fish length of 26.2cm.

Week 28: July 10- July 16
877 T (16 landings) landed on Gannet Dry Ledge average fish length of 26.3cm, 184 T (4 landings) landed on German Bank average fish length 26.6cm, 1,761 T (37 landings) landed on the Grand Manan Banks average fish length 24.3cm, 76T (1 landing) landed on the SW grounds, and 1,170T (20 Landings) landed on Seal Island average fish length 26.2cm.

Week 29: July 17- July 23
235 T (4 landings) from Gannet Dry Ledge average fish length 24.6cm, 1,303 T (22 landings) from German Bank average fish length 26.2cm, 1,548 T (37 landings) from the Grand Manan Banks average fish length 23.6cm, 103 T (1 landing) from the Long Island Shore average fish length 25.5cm, 71 T (3 landings) from Seal Island were made this week.

Week 30: July 24- July 30
Five seiners fished Scots Bay this week and landed roe fish for four nights. 1,041 T of herring was landed from 18 landings made in Scots Bay. The average length of the herring caught in Scots Bay was 26.5cm. 202 T (5 landings) was caught on Gannet Dry Ledge average fish length 26.7cm, 208 T (5 landings) was landed from German Bank average fish length 27.0cm, 116T (6 landings) was caught on the Grand Manan Banks average fish length 24.4cm, 16T (1 landing) caught on the Long Island Shore average fish length 25.5cm, and 311 T (6 landings) landed from Trinity with an average fish length of 26.4cm.

Week 31: July 31- August 6
The first survey of Scots Bay was completed on Sunday July 31, 2005. It involved 4 seiners. No fish were landed the night of the survey. Fish were landed the following evening. The vessels reported that fish were not showing up as well as they had mid-week the week before. 80 T of herring was landed from 1 landing made in Scots Bay this week with fish averaging 25.9cm in length. 93 T (1 landing) of fish was caught on German Bank, 69 T (4 landings) on the Grand Manan Banks average length 25.2cm, 9 T (1

Appendix A. 2005 4WX Herring Fishery: Report of Fleet Activity.

landing) on Long Island Shore average length 26.3cm, 761 T (18 landings) on Lurcher Shoal average length 26.3cm, and 946T (16 landings) on Trinity Ledge with an average length of 26.6cm.

Week 32: August 7- August 13
A good showing of fish in Scots Bay was noted on August 7 and 8. 648 T of herring was landed in Scots Bay this week from 15 landings. The average length of the fish caught in Scots Bay was 26.1cm. 334 T was landed on Gannet Dry ledge from 10 landings average fish length of 23.2cm and 17 T of herring was caught from one landing was caught on German Bank.

Week 33: August 14- August 20
Roe fish was first landed on German Bank the night of August 18th. 105 T of herring was caught on German Bank from 4 landings this week. 810 T of herring was caught in Scots Bay from 16 landings this week. The average length of herring caught in Scots Bay was 25.9cm. 482 T of herring was caught on Yankee Bank from 6 landings this week with an average fish length of 25.8cm.

Week 34: August 21- August 27
The second structured survey of Scot's Bay was completed on Sunday August 21, 2005. It involved the cooperation of 12 seiners. 2,771 T of herring was caught from 37 landings in Scots Bay this week. The average fish length of herring caught in Scots Bay this week was 26.8cm. Roe fish was landed again on German Bank the night of August 23rd. It was discussed that the first wave of roe fish was missed and not documented in a structured survey. 329 T of herring was caught on German Bank from 5 landings this week. 54 T (1 landing) was landed on Gannet Dry Ledge, 23 T (1 landing) from the Grand Manan Banks, 143 (8 landings) from the Long Island Shore average fish length of 21.9cm, 79 T (1 landing) from NB Coastal, 43 T (1 landing) from Yankee Bank.

Week 35: August 28- September 3
Some fish was seen throughout the week in Scots Bay. However a problem was a lack of seiner presence in the area. However, 571 T of herring was caught in Scots Bay this week from 11 landings. The average fish length of herring caught in Scots Bay this week was 26.2cm. 20 landings were made in German Bank this week, resulting in 1,015T of herring caught. Herring caught on German Banks averaged 27.1cm in length. 34 T (1 landing) were caught on Gannet Dry Ledge, 25 T (1 landing) on the Grand Manan Banks average fish length 24.8cm, 95 T (6 landings) on the Long Island Shore average fish length 24.2cm, and 21 T (1 landing) on Lurcher Shoal.

Week 36: September 4- September 10
Fish were noted in Scots Bay, but there were only two seiners fishing at the time, so conducting a survey was not possible at that time. 318T of herring was caught in Scots bay this week from 6 landings. 26.3cm was the average fish length of fish caught in Scots Bay this week. Boats were fishing roe fish on German Bank this week. It was reported that there were good amounts, but the fish were not in the best condition. The first structured survey of German Bank was conducted on September 7th, and was completed with the aid and direction of 11 seiners. 2,744 T of herring was taken from German Bank this week in 42 landings. The average fish length on German Bank was 27.1cm this week. Roe fish was taken from Trinity Ledge for several nights by 4-6 gill-netters during the week. 178 T (4 landings) was caught on the Long Island Shore average fish length 21.4cm, 189 T (4 landings) on the SW Grounds average fish length of 23.9cm, and 48 T (2 landings) at Seal Island.

Week 37: September 11- September 17
The third structured survey of Scots Bay was completed on Sunday September 11th, 2005. 5 seiners and one carrier participated. A large amount of roe fish was noted on the spawn toe part of German Bank. 1,521 T of herring was caught on German Bank this week from 32 landings. The average fish length on German Bank this week was 27.0cm. 29 T (1 landing) was caught on the Grand Manan Banks, 420 T (18 landings) on the Long Island Shore average fish length 22.7cm, 170 T (2 landing) on Lurcher average fish length 21.6cm, and 21 T (1 landing) on Trinity. Later in the week a good amount of wind was noted.

Week 38: September 18- September 24
The high winds did not chase the roe fish off German Bank. However, the winds did postpone survey activities early in the week. The second structured survey of German Bank was completed on September 21, 2005. 1,645 T of herring was caught on German Bank this week from 21 landings. The average length of herring caught on German Bank this week was 27.3cm. 281 T (5 landings) was caught on

Appendix A. 2005 4WX Herring Fishery: Report of Fleet Activity.

Gannet Dry Ledge average fish length of 27.1cm, 284 T (9 landings) was caught on the Long Island Shore average fish length of 22.7cm, 647 T (11 landings) was caught on Lurcher average fish length of 27.3cm, and 134 T (2 landings) was caught at Trinity.

Week 39: September 25- October 1
95 T (2 landings) was caught from German Bank average fish length of 27.4cm, 149T (4 landings) from the Grand Manan Banks average fish length of 26.1cm, and 1,391 T (38 landings) from the Long Island Shore with an average fish length of 19.6cm.

Week 40: October 2- October 8
The 3rd structured survey of German Bank was initiated on the evening of October 4th, 2005. Eight seiners participated in this survey. A good amount of roe fish were noted south of German Bank. The boats were able to get the fish they needed each night on German Bank. 2,427 T of herring was landed from German Bank this week from 32 landings. The average length of herring taken from German Bank this week was 27.4cm. 178 T (4 landings) was landed on Gannet Dry Ledge average fish length of 26.9cm, 400 T (13 landings) from the Grand Manan Banks average fish length of 26.0cm, 999 T (32 landings) from the Long Island Shore average fish length of 18.7cm, 9 T (1 landing) from Lurcher, and 3 T (1 landing) from Yankee Bank.

Week 41: October 9- October 14
Roe fish came off German Bank early this week. The weather was quite windy this week, and the bait market was being filled for most of the week. This made it difficult to get seiners out to check on German Bank in hopes of completing another survey. 1,162 T of herring was caught on German Bank this week from 12 landings. The average length of herring caught on German Bank this week was 25.5cm. The last survey of German Bank was completed on October 18th, 2005 by four seiners in a non-structured fashion. 151 T (5 landings) was landed from Gannet Dry Ledge average fish length of 27.0cm, 13 T (1 Landing) from the Grand Manan Banks, 578 T (11 landings) from the Long Island Shore average fish length 18.9cm, and 104 T (2 landings) from NB Coastal.

Acknowledgements:

Figure A1: 4WX Purse Seine Catches by Week
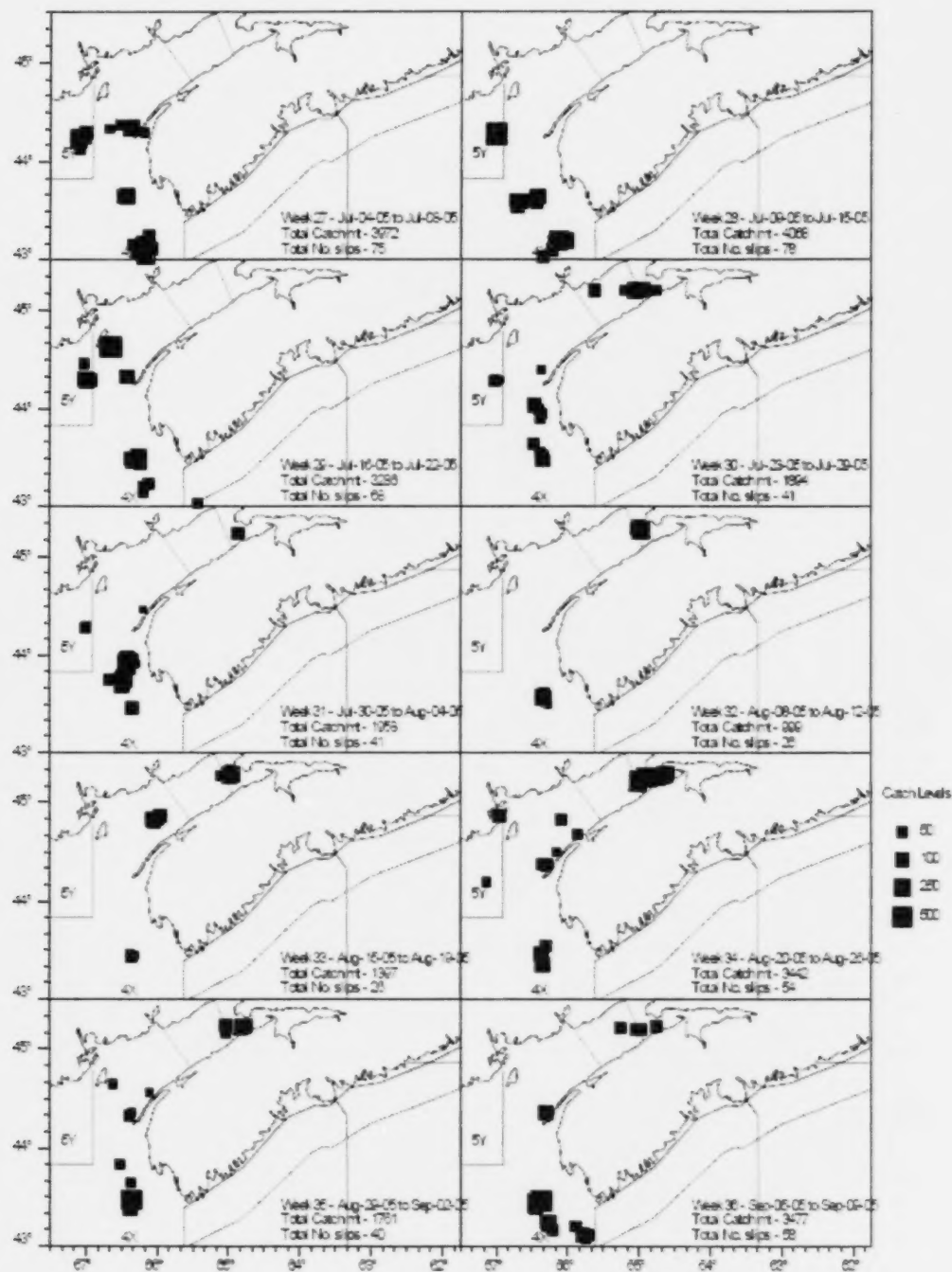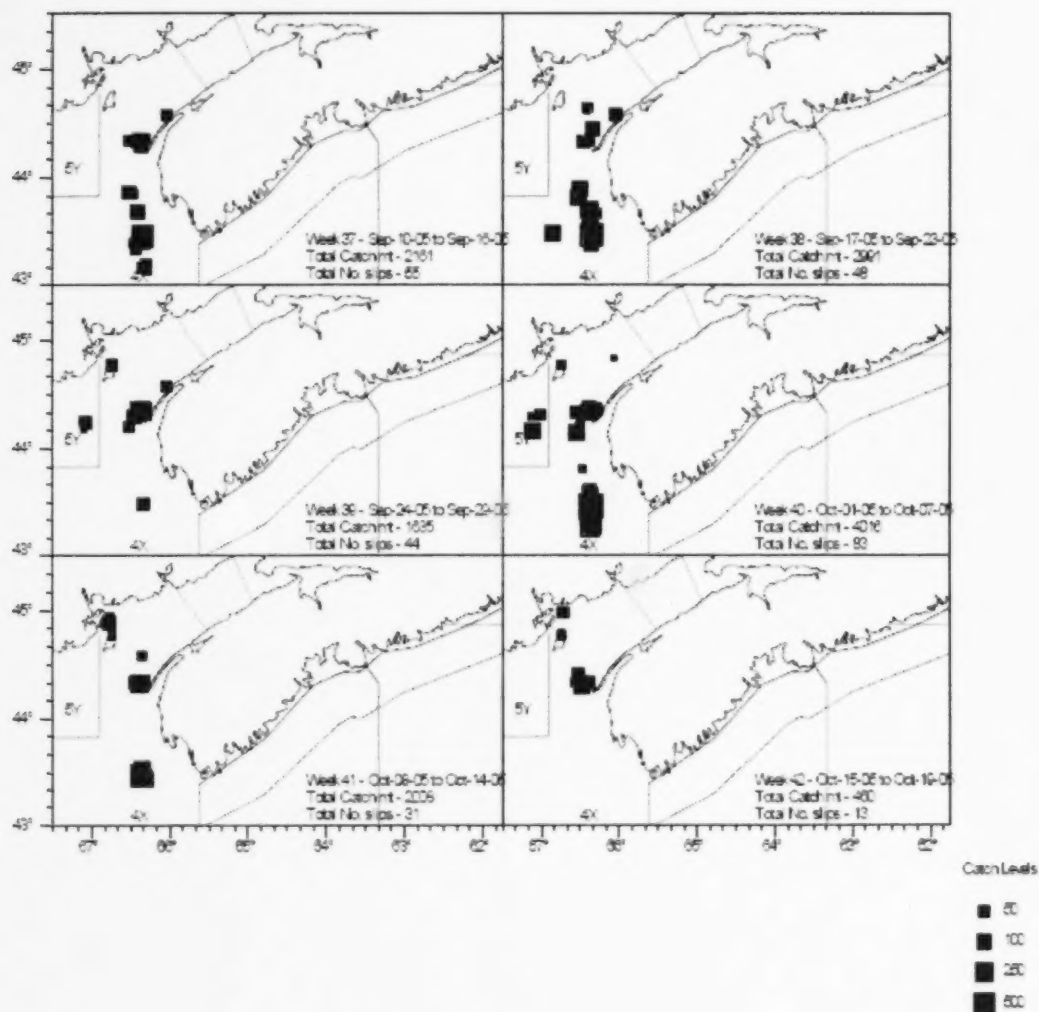
Figure A1 (cont.). 4WX Purse Seine Catches by Week

Figure A1 (cont.). 4WX Purse Seine Catches by Week

Purse Seine catches for 2004-2005 quota year
Catch dates from Oct-15-04 to Oct-14-05
Total Catch - 50391 t
Total Plotted Catch - 50391 t
Total No. slips - 1050
Maximum 1 mile square - 3234 t
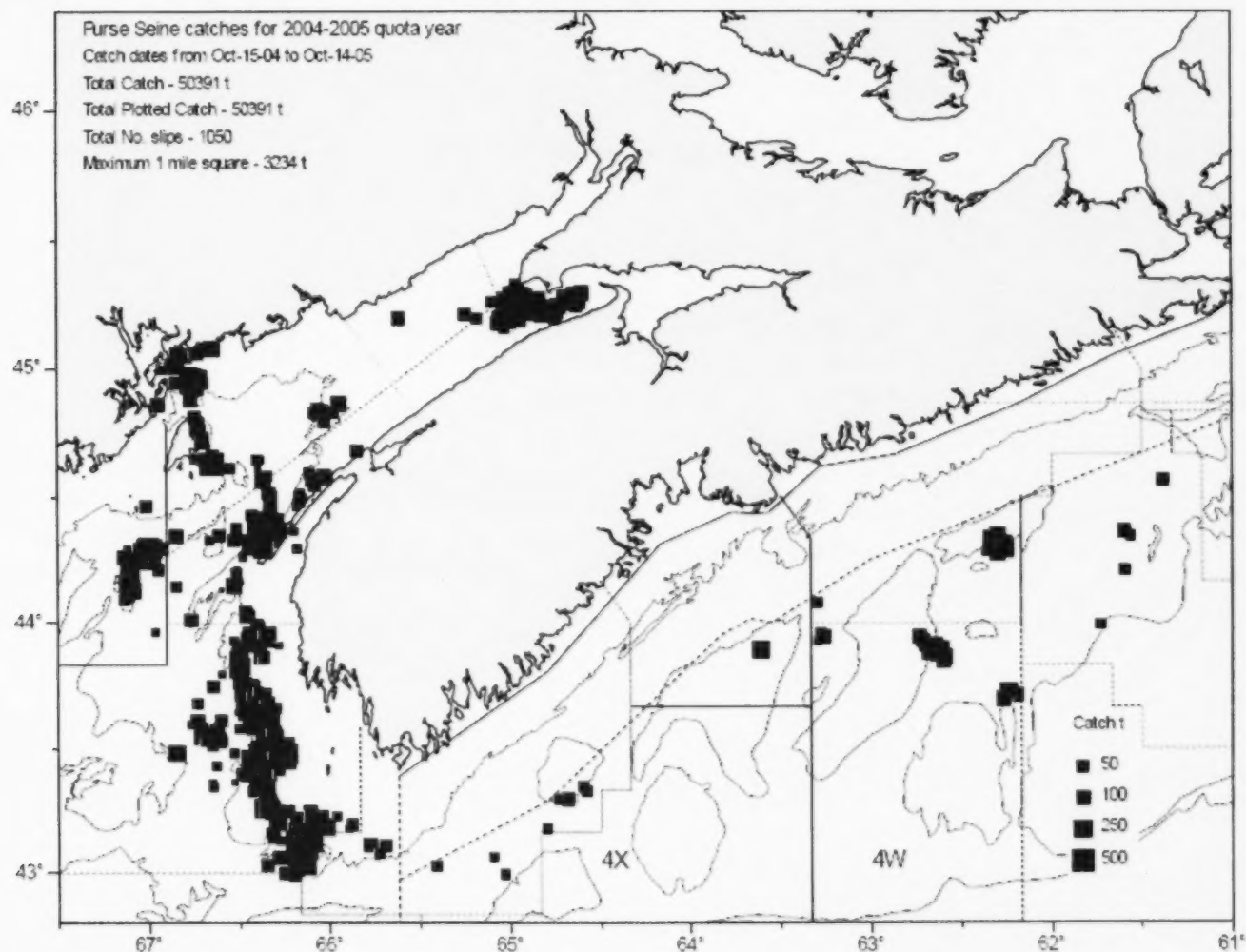
Figure A2: 4WX Purse Seine Catches for the 2004-2005 Quota Year

Appendix A. 2005 4WX Herring Fishery: Report of Fleet Activity.

Table A1: 4WX Landings by Week and by Area

Sum of CATCH_MT

YEAR	QYEAR	Fishing Grounds	1	2	3	19	20	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	Grand Total
2004	405	Gannet,Dry Ledge																										21				21
		Grand Manan																										132	27	45	175	379
		Long Island																										78				78
		N.B. Coastal																										513	562	361	116	1,552
	405 Total																											744	589	406	291	2,030
2004 Total																											744	589	406	291	2,030
2005	405	Gannet,Dry Ledge					262	62	15				432	877	235	202		334		54	34			281		178	151					3,117
		German Bank					39			16			1,268	184	1,303	208	93	17	105	329	1,015	2,744	1,521	1,645	95	2,427	1,162					14,171
		Grand Manan	15					12		437	89		946	1,761	1,548	116	69	9		23	25		29		149	400	13					5,632
		Long Island					1	1,189	628	91	686	621	293		103	16				143	95	178	420	284	1,391	999	578					7,725
		Lurcher				17	30	37									761				21		170	647		9						1,692
		N.B. Coastal	161	175	220															79							104					739
		S.W. Grounds											963	76								189										1,228
		Scots Bay														1,041	80	648	810	2,771	571	318										6,239
		Seal Island											69	1,170	71							48										1,358
		Trinity				23	13									311	946						21	134								1,448
		Unspecified												86	32		10		15		38											181
		Yankee Bank																	482	43						3						528
	405 Total		176	175	220	40	345	1,300	643	544	775	621	3,972	4,154	3,292	1,894	1,968	999	1,412	3,442	1,799	3,477	2,161	2,991	1,635	4,016	2,008					44,058
	506	Grand Manan																										106				108
		Long Island																										312				312
		N.B. Coastal																										48				48
	506 Total																											468				468
	2005	Offshore Banks					515		392	760	812	1,581																			55	4,115
		Shelburne							29																							29
		Western Hole					15	20	153						26																	214
	2005 Total						530	20	574	760	812	1,581			26																55	4,358
2005 Total			176	175	220	40	875	1,320	1,217	1,304	1,587	2,202	3,972	4,154	3,318	1,894	1,968	999	1,412	3,442	1,799	3,477	2,161	2,991	1,635	4,016	2,008	468			55	48,884
2006	506	Grand Manan	29																													29
		N.B. Coastal	417																													417
		Unspecified		16																												16
	506 Total		446	16																												462
2006 Total			446	16																												462
Grand Total			622	191	220	40	875	1,320	1,217	1,304	1,587	2,202	3,972	4,154	3,318	1,894	1,968	999	1,412	3,442	1,799	3,477	2,161	2,991	1,635	4,016	2,008	1,212	589	406	346	51,376

Appendix A. 2005 4WX Herring Fishery: Report of Fleet Activity.

Table A2: 4WX Average Herring Length by Week and Area

AREA	NAME	Data	1	2	20	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	Grand Total
1	Grand Manan	Average of MEAN_LEN			255			260	265		243	243	236	244	252				248				261	260		250	251
		Sum of No. Samples			1			9	3		14	23	14	2	2				1				1	10		3	83
2	Long Island	Average of MEAN_LEN				219	229	245	235	252	242		255	255	263			219	242	214	227	227	196	187	189	228	229
		Sum of No. Samples				18	17	2	16	12	8		1	1	2			2	4	4	10	3	7	5	1	1	114
3	Trinity	Average of MEAN_LEN												264	266												266
		Sum of No. Samples												5	11												16
4	Lurcher	Average of MEAN_LEN				225	265			294					263							216	273				256
		Sum of No. Samples				2	1			2					10							2	1				18
5	Gannet,Dry Ledge	Average of MEAN_LEN				221	266					253	263	246	267		232					271		269	270		256
		Sum of No. Samples				1	4					3	9	3	4		2					2		1	2		31
6	Seal Island	Average of MEAN_LEN										262	262														262
		Sum of No. Samples										1	9														10
7	German Bank	Average of MEAN_LEN										257	266	262	270					271	271	270	273	274	274	255	268
		Sum of No. Samples										8	2	9	2					3	24	12	12	2	12	5	91
8	Scots Bay	Average of MEAN_LEN											265	259	261	259	268	262	263								262
		Sum of No. Samples											13	1	12	12	19	10	6								73
10	N.B. Coastal	Average of MEAN_LEN	169	150																					242	188	187
		Sum of No. Samples	3	2																					2	2	9
11	S.W. Grounds	Average of MEAN_LEN								257										239							248
		Sum of No. Samples								6										2							8
13	Yankee Bank	Average of MEAN_LEN														258	241										250
		Sum of No. Samples														1	1										2
17	Western Hole	Average of MEAN_LEN					272			255																	264
		Sum of No. Samples					2			2																	4
19	Shelburne	Average of MEAN_LEN					260		287																		274
		Sum of No. Samples					1		2																		3
20	Offshore Banks	Average of MEAN_LEN				292		282	290	287	292																289
		Sum of No. Samples				1		3	5	9	7																25
Total Average of MEAN_LEN			169	150	246	245	261	265	268	283	253	258	250	261	262	247	259	243	257	247	238	261	244	247	239	222	251
Total Sum of No. Samples			3	2	4	24	23	16	30	21	42	43	27	27	26	14	13	22	18	36	24	18	10	28	10	6	487

Appendix B. VPA formulation and model output for overall acoustic index (ages 4-8).

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THURSDAY, APRIL 6, 2006  10:46:13.027 AM

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APL  Ver. 4.0.03

ADAPT_W  Ver. 3.0

Workspace size = 16000000
```

Catch

	1	2	3	4	5	6	7	8	9	10	11
1965.00	270378	1084719	34835	234383	49925	10592	1693	561	54	37	1
1966.00	154323	914093	448940	73382	321857	45916	13970	7722	1690	215	1
1967.00	722208	613970	153626	266454	110051	159203	57948	4497	409	296	148
1968.00	164703	2389061	224956	83109	290285	73087	90617	31977	15441	5668	1175
1969.00	108875	290329	531812	132319	162439	112631	62506	22595	6345	2693	722
1970.00	699720	576896	76532	286278	201215	120280	111937	41257	21271	7039	2674
1971.00	87570	404224	183896	106630	113566	93620	50022	36618	7536	5695	
1972.00	0	649254	71984	148516	77207	75384	49065	48700	26055	13792	11679
1973.00	1018	167454	781061	130851	40128	30334	22046	20249	23871	11630	13386
1974.00	18411	766064	93606	803651	68276	19093	10232	6565	12786	7102	9031
1975.00	3199	317641	239827	124599	514605	66302	12298	4409	4778	3847	6225
1976.00	240	55596	206535	153782	68804	268839	21460	5571	3951	2059	3446
1977.00	1170	153921	31572	218478	119234	51173	177247	13977	3170	1415	3894
1978.00	35381	383611	40887	12906	122108	68410	31088	108975	11082	2425	1676
1979.00	342	183982	250393	54620	5430	23142	18255	11836	41389	4527	2411
1980.00	2339	12503	80518	474091	27930	4373	4692	6560	2985	10641	2739
1981.00	0	103051	50883	102743	451482	32978	2418	2767	1917	538	2149
1982.00	3589	102133	150764	22640	98206	211043	14627	2080	1354	1250	1014
1983.00	5488	191682	150328	244007	24483	60678	89982	10352	1728	642	1324
1984.00	0	88433	243542	224354	146096	22716	21654	28299	9515	2183	9000
1985.00	9022	216740	337591	302782	147670	42404	14075	18178	7997	1201	470
1986.00	63	125300	275903	292792	56937	31599	10770	4320	2942	1356	349
1987.00	2300	82940	126436	527443	242597	45933	19481	7292	3361	3120	650
1988.00	151	148399	113208	195096	434192	236089	42533	21208	4186	3797	2845
1989.00	8	101788	114095	61842	79451	169023	76684	18303	8270	3814	3057
1990.00	0	178532	130176	171560	89922	101066	201901	116788	31466	10572	6848
1991.00	0	96960	179463	183647	88431	41352	50380	80732	45516	18291	13524
1992.00	9	168561	132642	286923	126510	75473	34458	35369	59136	34558	20653
1993.00	166	76405	43766	194198	130713	67708	33820	21481	21893	20684	11175
1994.00	151	103885	142260	53700	118015	72512	36059	14889	8706	10447	15533
1995.00	1831	113457	219777	112245	36784	36402	22127	6474	4217	2957	3566
1996.00	0	37496	37715	256063	54534	16862	9151	3300	1782	1310	1605
1997.00	356	56561	87395	78098	131062	18917	5131	3636	894	620	874
1998.00	137	264901	62322	138751	97065	97464	20679	3856	1730	1288	398
1999.00	2694	112893	223283	147840	131463	57291	10044	613	212	70	13
2000.00	841	364078	75330	108560	124083	60754	25829	4454	251	33	23
2001.00	51	73368	325273	57175	60409	31891	15509	2203	304	8	4
2002.00	15500	303723	98597	210620	75256	27973	12846	1577	70	23	3
2003.00	459	486345	342592	114850	96847	13111	7136	435	23	0	0
2004.00	3142	320628	347693	132570	79884	9351	3226	339	36	1	0
2005.00	135	72039	171155	180893	28030	4286	1050	49	2	2	0
2006.00											

Acoustic Overall

	2	3	4	5	6	7	8	9
1999.65	22.25	11836.78	**************************************				5774.58	6645.49
2000.65	**						37272.51	2018.98
2001.65	87169.63	*************************************					25436.16	2177.56
2002.65	81122.11	***************************************					17361.89	798.75
2003.65	**					59548.39	2080.84	0.82
2004.65	25675.28	**				47311.95	3274.62	2271.29
2005.65	3705.11	******************************	50696.07	15687.01	629.27	0.00		

```
Index Type and Model Form
ID# þ Label þ  Age Group(s) þ Index Type þ Model Form
 1 Acoustic Overall 2 Abundance Proportional
 2 Acoustic Overall 3 Abundance Proportional
 3 Acoustic Overall 4 Abundance Proportional
 4 Acoustic Overall 5 Abundance Proportional
 5 Acoustic Overall 6 Abundance Proportional
```

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    6 Acoustic Overall 7 Abundance Proportional
    7 Acoustic Overall 8 Abundance Proportional
    8 Acoustic Overall 9 Abundance Proportional

  Index Inclusion
  ID# on same line have common catchability
    3
    4
    5
    6
    7
  VPA setup

  Plus Group : Yes, using FIRST method

  Population
             1        2        3        4        5        6        7        8        9        10       11+
   1965.00
   2005.00********
   2006.00********                                                                                      (500)
  F ratios                                                             5000

             1        2        3        4        5        6        7        8        9        10       11+
   1965.00
   1966.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1967.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1968.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1969.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1970.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1971.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1972.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1973.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1974.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1975.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1976.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1977.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1978.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1979.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1980.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1981.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1982.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1983.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1984.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1985.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1986.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1987.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1988.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1989.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1990.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1991.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1992.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1993.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1994.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1995.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1996.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1997.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1998.00                                                  1.00     1.00     1.00     1.00   **wtd**
   1999.00                                                  1.00     1.00     1.00     1.00   **wtd**
   2000.00                                                  1.00     1.00     1.00     1.00   **wtd**
   2001.00                                                  1.00     1.00     1.00     1.00   **wtd**
   2002.00                                                  1.00     1.00     1.00     1.00   **wtd**
   2002.00                                                  1.00     1.00     1.00   **wtd**
   2004.00                                                  1.00     1.00     1.00     1.00   **wtd**
   2005.00                                                  1.00     1.00     1.00     1.00   **wtd**
   2005.00   ********
   2005.00            ********
   2005.00                     ********
   2005.00                              ********
   2005.00                                       ********   1.00
   2005.00                                                  1.00     ********
   2005.00                                                  1.00              ********
   2005.00                                                  1.00                       ********
  Natural Mortality                                         1.00                                ********
             1        2        3        4        5        6        7        8        9        10       11+
   1965.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
   1966.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
   1967.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
```

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Appendix B. VPA formulation and model output for overall acoustic index (ages 4-8).

Year											
1968.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1969.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1970.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1971.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1972.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1973.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1974.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1975.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1976.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1977.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1978.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1979.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1980.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1981.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1982.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1983.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1984.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1985.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1986.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1987.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1988.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1989.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1990.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1991.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1992.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1993.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1994.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1995.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1996.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1997.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1998.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1999.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2000.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2001.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2002.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2003.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2004.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2005.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)

Virtual Population Analysis using initial values

Population Numbers

Year	1	2	3	4	5	6	7	8	9	10	11+
1965.00	3503534	3848688	995990	1312007	348049	92556	44658	4104	1354	406	500
1966.00	2737874	2624572	2177169	784001	863223	239988	66231	35035	2855	1060	707
1967.00	6078739	2102325	1329624	1378701	575717	418512	155171	41661	21740	836	1253
1968.00	1286168	4325977	1170158	950142	889042	372334	200109	75150	30056	17430	1311
1969.00	1754254	904620	1415817	755635	702962	467578	239085	82892	32938	10845	9244
1970.00	2304087	1338027	480252	682955	499558	429512	281595	139599	47575	21258	13377
1971.00	7460417	1258574	579796	324285	303152	228931	243661	130382	77266	19947	19640
1972.00	1138007	6028985	667899	309749	169889	146502	119687	115682	61966	30575	20551
1973.00	2336523	931722	4350854	481941	121063	70132	52761	54102	51165	27434	19153
1974.00	1625829	1912063	612115	2859195	277069	63139	30305	23481	26162	20577	15921
1975.00	247148	1314489	880008	416859	1619372	165491	34561	15639	13330	10013	15485
1976.00	721820	199458	790742	505119	229479	864256	76167	17278	8846	6633	11863
1977.00	4140081	590760	113384	461878	275572	126138	466414	43093	9149	3712	10203
1978.00	1346539	3388555	345406	64483	183136	119041	57492	223170	22748	4650	6640
1979.00	449147	1070508	2428553	245946	41184	41880	36645	19392	85497	8737	5577
1980.00	1572597	367422	710839	1762596	152252	28826	13695	13722	5372	33069	5530
1981.00	1669558	1285420	289532	509412	1017308	99518	19663	7007	5380	1742	19616
1982.00	2302838	1366918	959467	191249	324646	429491	51910	13919	3261	2687	15067
1983.00	4078526	1882162	1027010	649785	136177	177675	163382	29368	9523	1459	12505
1984.00	5027282	3334258	1368174	705445	313499	89457	91079	53687	14768	6242	9665
1985.00	1831381	4115990	2650014	900962	376337	126231	52832	55107	18746	3661	3339
1986.00	1059694	1491259	3174295	1865457	466203	175953	65334	30614	28818	8199	4231
1987.00	1397308	867547	1107935	2350078	1263651	330385	115618	43794	21173	20942	8641
1988.00	1401917	1141942	635504	793142	1449860	816306	229118	77122	29291	14308	20824
1989.00	1744614	1147656	801233	418412	474051	797404	456413	149310	44098	20211	22791
1990.00	1185719	1428362	847830	553220	286868	316593	500847	304643	105751	28662	29020
1991.00	579910	970785	1008567	576914	299026	154203	168557	229416	144866	58343	31602
1992.00	824078	474790	707394	664216	307618	165457	89111	92791	115487	77777	45143
1993.00	1669807	674690	237693	459804	287340	138696	68056	42113	44305	41843	51315
1994.00	877050	1366972	483523	155220	202812	118503	53150	25557	15331	16747	47773
1995.00	1031472	717932	1025476	268195	78955	61164	32668	11627	7693	4810	29629
1996.00	913366	842844	485628	641941	119202	31801	17745	7177	3759	2545	22358
1997.00	1190214	747801	656219	363581	296445	48890	11017	6373	2929	1487	17773

1998.00	619708	974143	561228	458528	227441	125595	23094	4439	1984	1596	14426
1999.00	1704923	507250	559670	403319	250907	99434	17222	1005	282	121	11630
2000.00	708686	1393439	313795	258420	197789	88303	30480	5174	279	44	9547
2001.00	1396028	579463	813807	189211	114499	51897	18599	2432	359	11	7803
2002.00	2336388	1142925	408314	375233	103608	39933	14190	1682	88	29	6387
2003.00	1808667	1898873	662950	245688	119859	18475	7989	518	26	11	5230
2004.00	903803	1480397	1117735	237472	98615	13315	3554	361	45	1	4291
2005.00	1000000	737133	923717	603204	76483	10792	2644	123	5	5	3513
2006.00	1000000	818609	538562	602250	331532	37512	5000	1225	57	2	2879

Fishing Mortality

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	0.089	0.370	0.039	0.219	0.172	0.135	0.043	0.163	0.045	0.106	0.002
1966.00	0.064	0.480	0.257	0.109	0.524	0.236	0.264	0.277	1.028	0.252	0.002
1967.00	0.140	0.386	0.136	0.239	0.236	0.538	0.525	0.127	0.021	0.490	0.139
1968.00	0.152	0.917	0.237	0.101	0.443	0.243	0.681	0.625	0.819	0.440	2.943
1969.00	0.071	0.433	0.529	0.214	0.293	0.307	0.338	0.355	0.238	0.318	0.090
1970.00	0.405	0.636	0.193	0.612	0.560	0.367	0.570	0.392	0.669	0.450	0.248
1971.00	0.013	0.434	0.427	0.446	0.527	0.449	0.545	0.544	0.727	0.533	0.383
1972.00	0.000	0.126	0.126	0.739	0.685	0.821	0.594	0.616	0.615	0.678	0.960
1973.00	0.000	0.220	0.220	0.354	0.451	0.639	0.610	0.527	0.711	0.622	1.402
1974.00	0.013	0.576	0.184	0.369	0.315	0.403	0.462	0.366	0.760	0.475	0.958
1975.00	0.014	0.308	0.355	0.397	0.428	0.576	0.493	0.370	0.498	0.545	0.579
1976.00	0.000	0.365	0.338	0.406	0.398	0.417	0.370	0.436	0.668	0.416	0.383
1977.00	0.000	0.337	0.364	0.725	0.639	0.586	0.537	0.439	0.477	0.539	0.540
1978.00	0.029	0.133	0.140	0.248	1.275	0.978	0.887	0.759	0.757	0.838	0.324
1979.00	0.001	0.209	0.121	0.286	0.157	0.918	0.782	1.084	0.750	0.830	0.639
1980.00	0.002	0.038	0.133	0.350	0.225	0.183	0.470	0.736	0.926	0.435	0.776
1981.00	0.000	0.092	0.215	0.251	0.662	0.451	0.145	0.565	0.494	0.413	0.129
1982.00	0.002	0.086	0.190	0.140	0.403	0.767	0.370	0.180	0.604	0.708	0.077
1983.00	0.001	0.119	0.176	0.529	0.220	0.468	0.913	0.487	0.222	0.655	0.124
1984.00	0.000	0.030	0.218	0.428	0.710	0.327	0.302	0.852	1.195	0.483	3.753
1985.00	0.005	0.060	0.151	0.459	0.560	0.459	0.346	0.448	0.627	0.445	0.168
1986.00	0.000	0.097	0.101	0.190	0.144	0.220	0.200	0.169	0.119	0.201	0.095
1987.00	0.002	0.111	0.134	0.283	0.237	0.166	0.205	0.202	0.192	0.179	0.087
1988.00	0.000	0.154	0.218	0.315	0.398	0.381	0.228	0.359	0.171	0.344	0.163
1989.00	0.000	0.103	0.170	0.177	0.204	0.265	0.204	0.145	0.231	0.232	0.160
1990.00	0.000	0.148	0.185	0.415	0.421	0.430	0.581	0.543	0.395	0.517	0.300
1991.00	0.000	0.117	0.218	0.429	0.392	0.348	0.397	0.486	0.422	0.421	0.630
1992.00	0.000	0.492	0.231	0.638	0.597	0.688	0.550	0.539	0.815	0.663	0.691
1993.00	0.000	0.133	0.226	0.619	0.686	0.759	0.779	0.810	0.773	0.773	0.273
1994.00	0.000	0.087	0.389	0.476	0.999	1.089	1.320	1.001	0.959	1.126	0.440
1995.00	0.002	0.191	0.268	0.611	0.709	1.037	1.315	0.929	0.906	1.098	0.142
1996.00	0.000	0.050	0.089	0.573	0.691	0.860	0.824	0.696	0.727	0.822	0.082
1997.00	0.000	0.087	0.158	0.269	0.659	0.709	0.550	0.967	0.407	0.608	0.056
1998.00	0.000	0.354	0.130	0.403	0.627	1.787	2.934	2.558	2.597	1.990	0.031
1999.00	0.002	0.280	0.573	0.513	0.844	0.982	1.003	1.082	1.657	0.988	0.001
2000.00	0.001	0.338	0.306	0.614	1.138	1.358	2.328	2.468	3.009	1.646	0.003
2001.00	0.000	0.150	0.574	0.402	0.853	1.097	2.203	3.121	2.321	1.451	0.001
2002.00	0.007	0.345	0.308	0.941	1.524	1.409	3.110	3.973	1.919	1.919	0.001
2003.00	0.000	0.330	0.827	0.713	1.997	1.448	2.898	2.251	2.811	0.000	0.000
2004.00	0.004	0.272	0.417	0.933	2.012	1.417	3.160	4.071	1.983	1.832	0.000
2005.00	0.000	0.114	0.228	0.399	0.512	0.569	0.569	0.569	0.569	0.569	0.000

```
LAMBDA       1.00000Eý2
RSS          1.85678E1
NPHI         1.85678E1

Parameters
   8.51719E0

LAMBDA       1.00000Eý3
RSS          1.62243E1
NPHI         1.62243E1

Parameters
   7.74421E0

LAMBDA       1.00000Eý4
RSS          1.59787E1
NPHI         1.59787E1

Parameters
   7.46868E0
```

Appendix B. VPA formulation and model output for overall acoustic index (ages 4-8).

```
LAMBDA      1.00000Eý5
RSS         1.59550E1
NPHI        1.59550E1

Parameters
   7.38005E0

LAMBDA      1.00000Eý5
RSS         1.59529E1
NPHI        1.59529E1

Parameters
   7.35316E0

LAMBDA      1.00000Eý5
RSS         1.59527E1
NPHI        1.59527E1

Parameters
   7.34517E0

LAMBDA      1.00000Eý5
RSS         1.59527E1
NPHI        1.59527E1

Parameters
   7.34281E0
RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN 0.00001

LAMBDA      1.00000Eý2
RSS         1.59527E1
NPHI        1.59527E1

Parameters
   7.34281E0      1.75100E0      2.78829E0      2.88127E0      3.84886E0      3.89348E0

LAMBDA      1.00000Eý3
RSS         1.59527E1
NPHI        1.59527E1

Parameters
   7.34212E0      1.75110E0      2.78838E0      2.88136E0      3.84895E0      3.89358E0

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN 0.00001

Estimated VPA (biased)

Population Numbers
            1        2        3        4        5        6        7        8        9       10      11+
 1965.00 3503534 3848688   995990 1312007   348049    92556    44658     4104     1354      406      500
 1966.00 2737874 2624572 2177169   784001   863223   239988    66231    35035     2855     1060      707
 1967.00 6078739 2102325 1329624 1378701   575717   418512   155171    41661    21740      836     1253
 1968.00 1286168 4325977 1170158   950142   889042   372334   200109    75150    30056    17430     1311
 1969.00 1754254   904620 1415817   755635   702962   467578   239085    82892    32938    10845     9244
 1970.00 2304087 1338027   480252   682955   499558   429512   281595   139599    47575    21258    13377
 1971.00 7460417 1258574   579796   324285   303152   228973   243661   130382    77266    19947    19640
 1972.00 1138007 6028985   667899   309749   169889   146502   119687   115682    61966    30575    20551
 1973.00 2336523   931722 4350854   481941   121063    70132    52761    54102    51165    27434    19153
 1974.00 1625829 1912063   612115 2859195   277069    63139    30305    23481    26162    20577    15921
 1975.00   247148 1314489   880008   416859 1619372   165491    34561    15639    13330    10013    15485
 1976.00   721820   199458   790742   505119   229479   864256    76167    17278     8846     6633    11863
 1977.00 4140081   590760   113384   461878   275572   126138   466414    43093     9149     3712    10203
 1978.00 1346539 3388555   345406    64483   183136   119041    57492   223170    22748     4650     6640
 1979.00   449147 1070508 2428553   245946    41184    41880    36645    19392    85497     8737     5577
 1980.00 1572597   367422   710839 1762596   152252    28826    13695    13722     5372    33069     5530
 1981.00 1669558 1285420   289532   509412 1017308    99518    19663     7007     5380     1742    19616
 1982.00 2302838 1366918   959467   191249   324646   429491    51910    13919     3261     2687    15067
 1983.00 4078526 1882162 1027010   649785   136177   177675   163382    29368     9523     1459    12505
 1984.00 5027282 3334258 1368174   705445   313499    89457    91079    53687    14768     6242     9665
 1985.00 1831438 4115990 2650014   900962   376337   126231    52832    55107    18746     3661     3339
 1986.00 1059694 1491259 3174295 1865457   466203   175953    65334    30614    28818     8199     4231
 1987.00 1397308   867547 1107935 2350078 1263651   330385   115618    43794    21173    20942     8641
 1988.00 1401917 1141942   635504   793142 1449860   816306   229118    77122    29291    14308    20824
 1989.00 1744614 1147656   801233   418412   474051   797404   456413   149310    44098    20211    22791
 1990.00 1185719 1428362   847830   553220   286868   316593   500847   304643   105751    28662    29020
```

1991.00	579910	970785	1008567	576914	299026	154203	168557	229416	144866	58343	31602
1992.00	824078	474790	707394	664216	307618	165457	89111	92791	115487	77777	45143
1993.00	1669807	674690	237693	459804	287340	138696	68056	42113	44305	41843	51315
1994.00	877050	1366972	483523	155220	202812	118503	53150	25557	15331	16747	47773
1995.00	1031471	717932	1025476	268195	78955	61164	32668	11627	7693	4810	29629
1996.00	913347	842843	485628	641941	119202	31801	17745	7177	3759	2545	22358
1997.00	1190195	747786	656218	363580	296445	48890	11017	6373	2929	1487	17773
1998.00	619435	974127	561216	458527	227441	125595	23094	4439	1984	1596	14426
1999.00	1700922	507027	559657	403309	250907	99434	17222	1005	282	121	11630
2000.00	695849	1390163	313612	258409	197781	88303	30480	5174	279	44	9547
2001.00	1323824	568953	811130	189061	114491	51891	18599	2432	359	44	7803
2002.00	1851683	1083810	399712	373054	103486	39926	14185	1682	88	29	6387
2003.00	1143490	1502031	614652	238657	118101	18379	7984	515	26	11	5230
2004.00	443442	935796	793604	198432	92909	11979	3478	357	42	1	4291
2005.00	1000000	360222	478777	339017	45154	6521	1598	75	3	3	3513
2006.00	1000000	818609	230118	238645	116465	12104	1544	378	18	1	2877

Fishing Mortality

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	0.089	0.370	0.039	0.219	0.172	0.135	0.043	0.163	0.045	0.106	0.002
1966.00	0.064	0.480	0.257	0.109	0.524	0.236	0.264	0.277	1.028	0.252	0.002
1967.00	0.140	0.386	0.136	0.239	0.236	0.538	0.525	0.127	0.021	0.490	0.139
1968.00	0.152	0.917	0.237	0.101	0.443	0.243	0.681	0.625	0.819	0.440	2.943
1969.00	0.071	0.433	0.529	0.214	0.293	0.307	0.338	0.355	0.238	0.318	0.090
1970.00	0.405	0.636	0.193	0.612	0.580	0.367	0.570	0.392	0.669	0.450	0.248
1971.00	0.013	0.434	0.427	0.446	0.527	0.449	0.545	0.544	0.727	0.533	0.383
1972.00	0.000	0.126	0.126	0.739	0.685	0.821	0.594	0.616	0.615	0.678	0.960
1973.00	0.000	0.220	0.220	0.354	0.451	0.639	0.610	0.527	0.711	0.622	1.402
1974.00	0.013	0.576	0.184	0.369	0.315	0.403	0.462	0.366	0.760	0.475	0.958
1975.00	0.014	0.308	0.355	0.397	0.428	0.576	0.493	0.370	0.498	0.545	0.579
1976.00	0.000	0.365	0.338	0.406	0.398	0.417	0.370	0.436	0.668	0.416	0.383
1977.00	0.000	0.337	0.364	0.725	0.639	0.586	0.537	0.439	0.477	0.539	0.540
1978.00	0.029	0.133	0.140	0.248	1.275	0.978	0.887	0.759	0.757	0.838	0.324
1979.00	0.001	0.209	0.121	0.280	0.157	0.918	0.782	1.084	0.750	0.830	0.639
1980.00	0.002	0.038	0.133	0.350	0.225	0.183	0.470	0.736	0.926	0.435	0.776
1981.00	0.000	0.092	0.215	0.251	0.662	0.451	0.145	0.565	0.494	0.413	0.129
1982.00	0.002	0.086	0.190	0.140	0.403	0.767	0.370	0.180	0.604	0.708	0.077
1983.00	0.001	0.119	0.176	0.529	0.220	0.468	0.913	0.487	0.222	0.655	0.124
1984.00	0.000	0.030	0.218	0.428	0.710	0.327	0.302	0.852	1.195	0.483	3.753
1985.00	0.005	0.060	0.151	0.459	0.560	0.459	0.346	0.448	0.627	0.445	0.168
1986.00	0.000	0.097	0.101	0.190	0.144	0.220	0.200	0.169	0.119	0.201	0.095
1987.00	0.002	0.111	0.134	0.283	0.237	0.166	0.205	0.202	0.192	0.179	0.087
1988.00	0.000	0.154	0.218	0.315	0.398	0.381	0.228	0.359	0.171	0.344	0.163
1989.00	0.000	0.103	0.170	0.177	0.204	0.265	0.204	0.145	0.231	0.232	0.160
1990.00	0.000	0.148	0.185	0.415	0.421	0.430	0.581	0.543	0.395	0.517	0.300
1991.00	0.000	0.117	0.218	0.429	0.392	0.348	0.397	0.486	0.422	0.421	0.630
1992.00	0.000	0.492	0.231	0.638	0.597	0.688	0.550	0.539	0.815	0.663	0.691
1993.00	0.000	0.133	0.226	0.619	0.686	0.759	0.779	0.810	0.773	0.773	0.273
1994.00	0.000	0.087	0.389	0.476	0.999	1.089	1.320	1.001	0.959	1.126	0.440
1995.00	0.002	0.191	0.268	0.611	0.709	1.037	1.315	0.929	0.906	1.098	0.142
1996.00	0.000	0.050	0.089	0.573	0.691	0.860	0.824	0.696	0.727	0.822	0.082
1997.00	0.000	0.087	0.158	0.269	0.659	0.550	0.709	0.967	0.407	0.608	0.056
1998.00	0.000	0.354	0.130	0.403	0.627	1.787	2.934	2.558	2.597	1.990	0.031
1999.00	0.002	0.280	0.573	0.513	0.844	0.982	1.003	1.082	1.657	0.988	0.001
2000.00	0.001	0.339	0.306	0.614	1.138	1.358	2.328	2.468	3.009	1.646	0.003
2001.00	0.000	0.153	0.577	0.403	0.853	1.097	2.203	3.121	2.321	1.451	0.001
2002.00	0.009	0.367	0.316	0.950	1.528	1.410	3.116	3.978	1.921	1.921	0.001
2003.00	0.000	0.438	0.931	0.743	2.088	1.465	2.908	2.306	2.878	0.000	0.000
2004.00	0.008	0.470	0.651	1.280	2.457	1.815	3.643	4.565	2.425	2.279	0.000
2005.00	0.000	0.248	0.496	0.868	1.117	1.241	1.241	1.241	1.241	1.241	0.000

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET......... 0.000813
MEAN SQUARE RESIDUALS 0.550093

Parameter	Est.	Std. Err.	Rel. Err.	Bias	Rel. Bias
N[2006 7]	1.54E3	7.61E2	0.493	1.65E2	0.107
q ID#[3]	5.76E0	1.66E0	0.288	2.22Eý1	0.038
q ID#[4]	1.63E1	4.69E0	0.289	6.38Eý1	0.039
q ID#[5]	1.78E1	5.15E0	0.289	7.11Eý1	0.040
q ID#[6]	4.69E1	1.35E1	0.288	1.88E0	0.040
q ID#[7]	4.91E1	1.42E1	0.289	1.96E0	0.040

Appendix B. VPA formulation and model output for overall acoustic index (ages 4-8).

VPA using analytical bias adjusted parameters (linear scale)
Population Numbers

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	3503534	3848688	995990	1312007	348049	92556	44658	4104	1354	406	500
1966.00	2737874	2624572	2177169	784001	863223	239988	66231	35035	2855	1060	707
1967.00	6078739	2102325	1329624	1378701	575717	418512	155171	41661	21740	836	1253
1968.00	1286168	4325977	1170158	950142	889042	372334	200109	75150	30056	17430	1311
1969.00	1754254	904620	1415817	755635	702962	467578	239085	82892	32938	10845	9244
1970.00	2304087	1338027	480252	682955	499558	429512	281595	139599	47575	21258	13377
1971.00	7460417	1258574	579796	324285	303152	228973	243661	130382	77266	19947	19640
1972.00	1138007	6028985	667899	309749	169889	146502	119687	115682	61966	30575	20551
1973.00	2336523	931722	4350854	481941	121063	70132	52761	54102	51165	27434	19153
1974.00	1625829	1912063	612115	2859195	277069	63139	30305	23481	26162	20577	15921
1975.00	247148	1314489	880008	416859	1619372	165491	34561	15639	13330	10013	15485
1976.00	721820	199458	790742	505119	229479	864256	76167	17278	8846	6633	11863
1977.00	4140081	590760	113384	461878	275572	126138	466414	43093	9149	3712	10203
1978.00	1346539	3388555	345406	64483	183136	119041	57492	223170	22748	4650	6640
1979.00	449147	1070508	2428553	245946	41184	41880	36645	19392	85497	8737	5577
1980.00	1572597	367422	710839	1762596	152252	28826	13695	13722	5372	33069	5530
1981.00	1669558	1285420	289532	509412	1017308	99518	19663	7007	5380	1742	19616
1982.00	2302838	1366918	959467	191249	324646	429491	51910	13919	3261	2687	15067
1983.00	4078526	1882162	1027010	649785	136177	177675	163382	29368	9523	1459	12505
1984.00	5027282	3334258	1368174	705445	313499	89457	91079	53687	14768	6242	9665
1985.00	1831381	4115990	2650014	900962	376337	126231	52832	55107	18746	3661	3339
1986.00	1059694	1491259	3174295	1865457	466203	175953	65334	30614	28818	8199	4231
1987.00	1397308	867547	1107935	2350078	1263651	330385	115618	43794	21173	20942	8641
1988.00	1401917	1141942	635504	793142	1449860	816306	229118	77122	29291	14308	20824
1989.00	1744614	1147656	801233	418412	474051	797404	456413	149310	44098	20211	22791
1990.00	1185719	1428362	847380	553220	286868	316593	500847	304643	105751	28662	29020
1991.00	579910	970785	1008567	576914	299026	154203	168557	229416	144866	58343	31602
1992.00	824078	474790	707394	664216	307618	165457	89111	92791	115487	77777	45143
1993.00	1669807	674690	237693	459804	287340	138696	68056	42113	44305	41843	51315
1994.00	877050	1366972	483523	155220	202812	118503	53150	25557	15331	16747	47773
1995.00	1031470	717932	1025476	268195	78955	61164	32668	11627	7693	4810	29629
1996.00	913346	842843	485628	641941	119202	31801	17745	7177	3759	2545	22358
1997.00	1190194	747785	656218	363580	296445	48890	11017	6373	2929	1487	17773
1998.00	619421	974127	561215	458527	227441	125595	23094	4439	1984	1596	14426
1999.00	1700724	507015	559656	403309	250907	99434	17222	1005	282	121	11630
2000.00	695211	1390002	313603	258409	197780	88303	30480	5174	279	44	9547
2001.00	1320249	568431	810998	189053	114490	51890	18599	2432	359	11	7803
2002.00	1827341	1080882	399285	372946	103480	39925	14185	1682	88	29	6387
2003.00	1109406	1482101	612261	238308	118014	18374	7983	515	26	11	5230
2004.00	419699	907890	777340	196503	92625	11913	3474	357	42	1	4291
2005.00	1000000	340782	456017	325797	43619	6314	1547	72	3	3	3513
2006.00	1000000	818609	214219	220091	105786	10874	1379	338	16	1	2877

Fishing Mortality

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	0.089	0.370	0.039	0.219	0.172	0.135	0.043	0.163	0.045	0.106	0.002
1966.00	0.064	0.480	0.257	0.109	0.524	0.236	0.264	0.277	1.028	0.252	0.002
1967.00	0.140	0.386	0.136	0.239	0.236	0.538	0.525	0.127	0.021	0.490	0.139
1968.00	0.152	0.917	0.237	0.101	0.443	0.243	0.681	0.625	0.819	0.440	2.943
1969.00	0.071	0.433	0.529	0.214	0.293	0.307	0.338	0.355	0.238	0.318	0.090
1970.00	0.405	0.636	0.193	0.612	0.580	0.367	0.570	0.392	0.669	0.450	0.248
1971.00	0.013	0.434	0.427	0.446	0.527	0.449	0.545	0.544	0.727	0.533	0.383
1972.00	0.000	0.126	0.126	0.739	0.685	0.821	0.594	0.616	0.615	0.678	0.960
1973.00	0.000	0.220	0.220	0.354	0.451	0.639	0.610	0.527	0.711	0.622	1.402
1974.00	0.013	0.576	0.184	0.369	0.315	0.403	0.462	0.366	0.760	0.475	0.958
1975.00	0.014	0.308	0.355	0.397	0.428	0.576	0.493	0.370	0.498	0.545	0.579
1976.00	0.000	0.365	0.338	0.406	0.398	0.417	0.370	0.436	0.668	0.416	0.383
1977.00	0.000	0.337	0.364	0.725	0.639	0.586	0.537	0.439	0.477	0.539	0.540
1978.00	0.029	0.133	0.140	0.248	1.275	0.978	0.887	0.759	0.757	0.838	0.324
1979.00	0.001	0.209	0.121	0.280	0.157	0.918	0.782	1.084	0.750	0.830	0.639
1980.00	0.002	0.038	0.133	0.350	0.225	0.183	0.470	0.736	0.926	0.435	0.776
1981.00	0.000	0.092	0.215	0.251	0.662	0.451	0.145	0.565	0.494	0.413	0.129
1982.00	0.002	0.086	0.190	0.140	0.403	0.767	0.370	0.180	0.604	0.708	0.077
1983.00	0.001	0.119	0.176	0.529	0.220	0.468	0.913	0.487	0.222	0.655	0.124
1984.00	0.000	0.030	0.218	0.428	0.710	0.327	0.302	0.852	1.195	0.483	3.753
1985.00	0.005	0.060	0.151	0.459	0.560	0.459	0.346	0.448	0.627	0.445	0.168
1986.00	0.000	0.097	0.101	0.190	0.144	0.220	0.200	0.169	0.119	0.201	0.095
1987.00	0.002	0.111	0.134	0.283	0.237	0.166	0.205	0.202	0.192	0.179	0.087
1988.00	0.000	0.154	0.218	0.315	0.398	0.381	0.228	0.359	0.171	0.344	0.163
1989.00	0.000	0.103	0.170	0.177	0.204	0.265	0.204	0.145	0.231	0.232	0.160
1990.00	0.000	0.148	0.185	0.415	0.421	0.430	0.581	0.543	0.395	0.517	0.300
1991.00	0.000	0.117	0.218	0.429	0.392	0.348	0.397	0.486	0.422	0.421	0.630

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1992.00   0.000   0.492   0.231   0.638   0.597   0.688   0.550   0.539   0.815   0.663   0.691
1993.00   0.000   0.133   0.226   0.619   0.686   0.759   0.779   0.810   0.773   0.773   0.273
1994.00   0.000   0.087   0.389   0.476   0.999   1.089   1.320   1.001   0.959   1.126   0.440
1995.00   0.002   0.191   0.268   0.611   0.709   1.037   1.315   0.929   0.906   1.098   0.142
1996.00   0.000   0.050   0.089   0.573   0.691   0.860   0.824   0.696   0.727   0.822   0.082
1997.00   0.000   0.087   0.158   0.269   0.659   0.550   0.709   0.967   0.407   0.608   0.056
1998.00   0.000   0.354   0.130   0.403   0.627   1.787   2.934   2.558   2.597   1.990   0.031
1999.00   0.002   0.280   0.573   0.513   0.844   0.982   1.003   1.082   1.657   0.988   0.001
2000.00   0.001   0.339   0.306   0.614   1.138   1.358   2.328   2.468   3.009   1.646   0.003
2001.00   0.000   0.153   0.577   0.403   0.853   1.097   2.203   3.121   2.321   1.451   0.001
2002.00   0.009   0.368   0.316   0.951   1.528   1.410   3.117   3.978   1.921   1.921   0.001
2003.00   0.000   0.445   0.936   0.745   2.093   1.466   2.908   2.309   2.882   0.000   0.000
2004.00   0.008   0.489   0.670   1.305   2.486   1.841   3.674   4.596   2.454   2.309   0.000
2005.00   0.000   0.264   0.528   0.925   1.189   1.321   1.321   1.321   1.321   1.321   0.000
```

```
Acoustic Overall
Age :   4
Ln calibration constant :       1.75110

    Year      Observed      Predicted      Residual       Ln Pop.
  --------   ----------    -----------    ----------     ---------
  1999.65    13.05395       14.19540      -1.14145       12.44430
  2000.65    13.44058       13.68426      -0.24368       11.93317
  2001.65    13.03457       13.50921      -0.47464       11.75811
  2002.65    14.47735       13.83295       0.64440       12.08186
  2003.65    13.73914       13.52066       0.21848       11.76956
  2004.65    13.99252       12.98703       1.00549       11.23593
  2005.65    13.78184       13.79030      -0.00847       12.03921

         Average squared residual :       0.43738

Acoustic Overall
Age :   5
Ln calibration constant :       2.78838

    Year      Observed      Predicted      Residual       Ln Pop.
  --------   ----------    -----------    ----------     ---------
  1999.65    14.04638       14.54242      -0.49604       11.75404
  2000.65    13.74356       14.11359      -0.37003       11.32520
  2001.65    13.05480       13.75187      -0.69708       10.96349
  2002.65    13.29224       13.21222       0.08002       10.42383
  2003.65    13.58783       12.98023       0.60760       10.19184
  2004.65    13.54056       12.50093       1.03963        9.71255
  2005.65    12.48637       12.65033      -0.16397        9.86195

         Average squared residual :       0.33603

Acoustic Overall
Age :   6
Ln calibration constant :       2.88136

    Year      Observed      Predicted      Residual       Ln Pop.
  --------   ----------    -----------    ----------     ---------
  1999.65    13.49367       13.62003      -0.12636       10.73867
  2000.65    13.11595       13.25741      -0.14146       10.37605
  2001.65    12.54234       12.89525      -0.35291       10.01388
  2002.65    12.29205       12.42989      -0.13784        9.54853
  2003.65    11.56020       11.61817      -0.05798        8.73681
  2004.65    11.67337       10.96269       0.71068        8.08132
  2005.65    10.83360       10.72760       0.10601        7.84623

         Average squared residual :       0.09988

Acoustic Overall
Age :   7
Ln calibration constant :       3.84895

    Year      Observed      Predicted      Residual       Ln Pop.
  --------   ----------    -----------    ----------     ---------
  1999.65    12.06117       12.82124      -0.76007        8.97229
  2000.65    12.27337       12.53034      -0.25696        8.68139
  2001.65    11.87029       12.11781      -0.24752        8.26886
  2002.65    11.70640       11.25332       0.45308        7.40437
  2003.65    10.99454       10.81410       0.18045        6.96515
  2004.65    10.76452        9.50532       1.25919        5.65637
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    2005.65          9.66059        10.28862      -0.62803       6.43967

                  Average squared residual :        0.41755

Acoustic Overall
Age :   8
Ln calibration constant :        3.89358

       Year          Observed        Predicted        Residual        Ln Pop.
      -------        --------        ---------        --------        -------
      1999.65         8.66122         9.97329        -1.31207        6.07971
      2000.65        10.52601        10.71082        -0.18481        6.81724
      2001.65        10.14393         9.53127         0.61265        5.63769
      2002.65         9.76203         8.60568         1.15635        4.71210
      2003.65         7.64053         8.50853        -0.86800        4.61495
      2004.65         8.09396         6.67398         1.41998        2.78040
      2005.65         6.44457         7.26853        -0.82396        3.37495

                  Average squared residual :        0.98812

      1.00 ý0.23 ý0.24 ý0.24 ý0.23 ý0.24
ý0.23 1.00  0.06  0.06  0.05  0.06
ý0.24 0.06  1.00  0.06  0.06  0.06
ý0.24 0.06  0.06  1.00  0.06  0.06
ý0.23 0.05  0.06  0.06  1.00  0.06
ý0.24 0.06  0.06  0.06  0.06  1.00

Acoustic Overall 4 Abundance Proportional
Acoustic Overall 5 Abundance Proportional
Acoustic Overall 6 Abundance Proportional
Acoustic Overall 7 Abundance Proportional
Acoustic Overall 8 Abundance Proportional
Autocorrelation : 0.6200936236

Projection results using analytical bias adjusted point estimates
Projected Population Numbers
              1        2        3        4        5        6        7        8        9       10      11+
   2006.00 1000000   818609   214219   220091   105786    10874     1379      338       16        1     2877
   2007.00 1000000   818731   643940   161903   156654    72343     7289      925      226       11     1929

Fishing Mortality
              1        2        3        4        5        6        7        8        9       10      11+
   2006.00  0.000    0.040    0.080    0.140    0.180    0.200    0.200    0.200    0.200    0.200    0.200

M
              1        2        3        4        5        6        7        8        9       10       11
   2006.00   0.20     0.20     0.20     0.20     0.20     0.20     0.20     0.20     0.20     0.20     0.20

PR
              1        2        3        4        5        6        7        8        9       10       11
   2006.00   0.00     0.20     0.40     0.70     0.90     1.00     1.00     1.00     1.00     1.00     1.00

Beg wt
              1        2        3        4        5        6        7        8        9       10       11
   2006.00   0.02     0.02     0.05     0.11     0.16     0.21     0.25     0.28     0.31     0.35     0.35
   2007.00   0.02     0.02     0.05     0.11     0.16     0.21     0.25     0.28     0.31     0.35     0.35

Projected Population Biomass
              1        2        3        4        5        6        7        8        9       10       11
   1+      2+       3+       4+
   2006.00  19046    15845    11525    24345    17227     2286      340       96        5        0     1019
   91734    72688    56843    45318
   2007.00  19046    15847    34645    17909    25511    15209     1796      261       70        4      683
   130982  111936    96089    61444

Projected Catch Numbers
              1        2        3        4        5        6        7        8        9       10       11
   2006.00      0    29111    14947    26121    15841     1792      227       56        3        0      474
   2007.00
```

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Appendix B. VPA formulation and model output for overall acoustic index (ages 4-8).

Avg wt

	1	2	3	4	5	6	7	8	9	10	11
2006.00	0.02	0.03	0.08	0.14	0.19	0.23	0.26	0.31	0.32	0.36	0.36

Projected Catch Biomass

	1	2	3	4	5	6	7	8	9	10	11
2006.00	0	1011	1244	3680	3033	417	60	17	1	0	173

1+	2+	3+	4+
9636	9636	8625	7381
2007.00			

Input for Analytical risk analysis of projection results

M

	1	2	3	4	5	6	7	8	9	10	11
2006.00	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

PR

	1	2	3	4	5	6	7	8	9	10	11
2006.00	0.00	0.20	0.40	0.70	0.90	1.00	1.00	1.00	1.00	1.00	1.00

Beg wt

	1	2	3	4	5	6	7	8	9	10	11
2006.00	0.02	0.02	0.05	0.11	0.16	0.21	0.25	0.28	0.31	0.35	0.35
2007.00	0.02	0.02	0.05	0.11	0.16	0.21	0.25	0.28	0.31	0.35	0.35

Avg wt

	1	2	3	4	5	6	7	8	9	10	11
2006.00	0.02	0.03	0.08	0.14	0.19	0.23	0.26	0.31	0.32	0.36	0.36

Maturity

	1	2	3	4	5	6	7	8	9	10	11
2006.00	0.00	0.00	0.50	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2007.00	0.00	0.00	0.50	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Appendix B. VPA formulation and model output for overall acoustic index (ages 4-8).

Inverse Exploitation Rate (Reference = 5.39)

Quota	Mean	Std. Err.	Bias	Adj. Mean	Prob
5000	12.433	5.060	1.088	11.345	0.120
10000	6.303	2.565	0.551	5.752	0.444
15000	4.264	1.735	0.373	3.891	0.806
20000	3.247	1.322	0.284	2.963	0.967
25000	2.640	1.074	0.231	2.409	0.997
30000	2.238	0.911	0.196	2.042	1.000
35000	1.953	0.795	0.171	1.782	1.000
40000	1.742	0.709	0.152	1.590	1.000
45000	1.581	0.643	0.138	1.443	1.000
50000	1.454	0.592	0.127	1.327	1.000
55000	1.354	0.551	0.118	1.235	1.000

% Biomass Change (Reference = 0)

Quota	Mean	Std. Err.	Bias	Adj. Mean	Prob
5000	65	11	2	63	0.000
10000	56	7	1	55	0.000
15000	46	4	1	46	0.000
20000	37	0	0	37	0.000
25000	28	3	ÿ1	29	0.000
30000	19	6	ÿ1	20	0.001
35000	10	10	ÿ2	11	0.120
40000	1	13	ÿ2	3	0.412
45000	ÿ8	16	ÿ3	ÿ6	0.636
50000	ÿ17	19	ÿ3	ÿ14	0.769
55000	ÿ26	22	ÿ3	ÿ23	0.846

Biomass (Reference = 100000)

Quota	Mean	Std. Err.	Bias	Adj. Mean	Prob
5000	87433	27129	5142	82291	0.743
10000	82497	27122	5144	77353	0.798
15000	77577	27109	5147	72430	0.845
20000	72678	27090	5153	67525	0.885
25000	67800	27061	5163	62637	0.916
30000	62946	27022	5178	57769	0.941
35000	58120	26969	5201	52919	0.960
40000	53325	26898	5236	48089	0.973
45000	48566	26805	5291	43275	0.983
50000	43849	26680	5378	38471	0.989
55000	39181	26513	5518	33663	0.994

Appendix C. VPA formulation and model output with German Bank acoustic index (ages 4-8).

```
THURSDAY, APRIL 6, 2006  11:36:37.113 AM

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APL  Ver. 4.0.03

ADAPT_W  Ver. 3.0

Workspace size = 16000000
```

Catch

	1	2	3	4	5	6	7	8	9	10	11
1965.00	270378	1084719	34835	234383	49925	10592	1693	561	54	37	1
1966.00	154323	914093	448940	73382	321857	45916	13970	7722	1690	215	1
1967.00	722208	613970	153626	266454	110051	159203	57948	4497	409	296	148
1968.00	164703	2389061	224956	83109	290285	73087	90617	31977	15441	5668	1175
1969.00	108875	290329	531812	132319	162439	112631	62506	22595	6345	2693	722
1970.00	699720	576896	76532	286278	201215	120280	111937	41257	21271	7039	2674
1971.00	87570	404224	183896	106630	113566	75593	93620	50022	36618	7536	5695
1972.00	0	649254	71984	148516	77207	75384	49065	48700	26055	13792	11679
1973.00	1018	167454	781061	130851	40128	30334	22046	20249	23871	11630	13386
1974.00	18411	766064	93606	803651	68276	19093	10232	6565	12786	7102	9031
1975.00	3199	317641	239827	124599	514605	66302	12298	4409	4778	3847	6225
1976.00	240	55596	206535	153782	68804	268839	21460	5571	3951	2059	3446
1977.00	1170	153921	31572	218478	119234	51173	177247	13977	3170	1415	3894
1978.00	35381	383611	40887	12906	122108	68410	31088	108975	11082	2425	1676
1979.00	342	183982	250393	54620	5430	23142	18255	11836	41389	4527	2411
1980.00	2339	12503	80518	474091	27930	4373	4692	6560	2985	10641	2739
1981.00	0	103051	50883	102743	451482	32978	2418	2767	1917	538	2149
1982.00	3589	102133	150764	22640	98206	211043	14627	2080	1354	1250	1014
1983.00	5488	191682	150328	244007	24483	60678	89982	10352	1728	642	1324
1984.00	0	88433	243542	224354	146096	22716	21654	28299	9515	2183	9000
1985.00	9022	216740	337591	302782	147670	42404	14075	18178	7997	1201	470
1986.00	63	125300	275903	292792	56937	31599	10770	4320	2942	1356	349
1987.00	2300	82940	126436	527443	242597	45933	19481	7292	3361	3120	650
1988.00	151	148399	113208	195096	434192	236089	42533	21208	4186	3797	2845
1989.00	8	101788	114095	61842	79451	169023	76684	18303	8270	3814	3057
1990.00	0	178532	130176	171560	89922	101066	201901	116788	31466	10572	6848
1991.00	0	96960	179463	183647	88431	41352	50380	80732	45516	18291	13524
1992.00	9	168561	132642	286923	126510	75473	34458	35369	59136	34558	20653
1993.00	166	76405	43766	194198	130713	67708	33820	21481	21893	20684	11175
1994.00	151	103885	142260	53700	118015	72512	36059	14889	8706	10447	15533
1995.00	1831	113457	219777	112245	36784	36402	22127	6474	4217	2957	3566
1996.00	0	37496	37715	256063	54534	16862	9151	3300	1782	1310	1605
1997.00	356	56561	87395	78098	131062	18917	5131	3636	894	620	874
1998.00	137	264901	62322	138751	97065	97464	20679	3856	1730	1288	398
1999.00	2694	112893	223283	147840	131463	57291	10044	613	212	70	13
2000.00	841	364078	75330	108560	124083	60754	25829	4454	251	33	23
2001.00	51	73368	325273	57175	60409	31891	15509	2203	364	8	4
2002.00	15500	303723	98597	210620	75258	27973	12846	1577	70	23	3
2003.00	459	486345	342592	114850	96847	13111	7136	435	23	0	0
2004.00	3142	320628	347693	132570	79884	9351	3226	339	36	1	0
2005.00	135	72039	171155	180893	28030	4286	1050	49	2	2	0
2006.00											

German Only Acoustic

	2	3	4	5	6	7	8	9
1999.65	0.00	9924.46	******	******	******	******	5561.42	6599.39
2000.65	******	******	******	******	******	******	26262.77	1630.55
2001.65	85238.48	******	******	******	******	61752.10	12399.95	1752.70
2002.65	78823.76	******	******	******	******	90875.38	13560.01	757.96
2003.65	******	******	******	******	71924.99	36656.17	1716.64	0.00
2004.65	22502.50	******	******	******	96777.68	37006.73	2585.67	2271.29
2005.65	3489.34	******	******	******	46492.96	14538.91	597.26	0.00

```
Index Type and Model Form
ID# þ Label þ  Age Group(s) þ Index Type þ Model Form
 1 German Only Acoustic 2 Abundance Proportional
 2 German Only Acoustic 3 Abundance Proportional
 3 German Only Acoustic 4 Abundance Proportional
 4 German Only Acoustic 5 Abundance Proportional
 5 German Only Acoustic 6 Abundance Proportional
 6 German Only Acoustic 7 Abundance Proportional
 7 German Only Acoustic 8 Abundance Proportional
```

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```
8 German Only Acoustic 9 Abundance Proportional

Index Inclusion
ID# on same line have common catchability
 3
 4
 5
 6
 7
VPA setup

Plus Group : Yes, using FIRST method
```

Population

	1	2	3	4	5	6	7	8	9	10	11+
1965.00											(500)
2005.00********											
2006.00********						5000					

F ratios

	1	2	3	4	5	6	7	8	9	10	11+
1965.00						1.00	1.00	1.00	1.00	**wtd**	
1966.00						1.00	1.00	1.00	1.00	**wtd**	
1967.00						1.00	1.00	1.00	1.00	**wtd**	
1968.00						1.00	1.00	1.00	1.00	**wtd**	
1969.00						1.00	1.00	1.00	1.00	**wtd**	
1970.00						1.00	1.00	1.00	1.00	**wtd**	
1971.00						1.00	1.00	1.00	1.00	**wtd**	
1972.00						1.00	1.00	1.00	1.00	**wtd**	
1973.00						1.00	1.00	1.00	1.00	**wtd**	
1974.00						1.00	1.00	1.00	1.00	**wtd**	
1975.00						1.00	1.00	1.00	1.00	**wtd**	
1976.00						1.00	1.00	1.00	1.00	**wtd**	
1977.00						1.00	1.00	1.00	1.00	**wtd**	
1978.00						1.00	1.00	1.00	1.00	**wtd**	
1979.00						1.00	1.00	1.00	1.00	**wtd**	
1980.00						1.00	1.00	1.00	1.00	**wtd**	
1981.00						1.00	1.00	1.00	1.00	**wtd**	
1982.00						1.00	1.00	1.00	1.00	**wtd**	
1983.00						1.00	1.00	1.00	1.00	**wtd**	
1984.00						1.00	1.00	1.00	1.00	**wtd**	
1985.00						1.00	1.00	1.00	1.00	**wtd**	
1986.00						1.00	1.00	1.00	1.00	**wtd**	
1987.00						1.00	1.00	1.00	1.00	**wtd**	
1988.00						1.00	1.00	1.00	1.00	**wtd**	
1989.00						1.00	1.00	1.00	1.00	**wtd**	
1990.00						1.00	1.00	1.00	1.00	**wtd**	
1991.00						1.00	1.00	1.00	1.00	**wtd**	
1992.00						1.00	1.00	1.00	1.00	**wtd**	
1993.00						1.00	1.00	1.00	1.00	**wtd**	
1994.00						1.00	1.00	1.00	1.00	**wtd**	
1995.00						1.00	1.00	1.00	1.00	**wtd**	
1996.00						1.00	1.00	1.00	1.00	**wtd**	
1997.00						1.00	1.00	1.00	1.00	**wtd**	
1998.00						1.00	1.00	1.00	1.00	**wtd**	
1999.00						1.00	1.00	1.00	1.00	**wtd**	
2000.00						1.00	1.00	1.00	1.00	**wtd**	
2001.00						1.00	1.00	1.00	1.00	**wtd**	
2002.00						1.00	1.00	1.00	**wtd**		
2002.00						1.00	1.00	1.00	1.00	**wtd**	
2004.00						1.00	1.00	1.00	1.00	**wtd**	
2005.00		********				0.20					
2005.00			********	********		0.40					
2005.00				********		0.70					
2005.00					********	0.90					
2005.00						1.00	********				
2005.00						1.00		********			
2005.00						1.00			********		
2005.00						1.00				********	

Natural Mortality

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1966.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1967.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1968.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1969.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)

```
1970.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1971.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1972.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1973.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1974.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1975.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1976.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1977.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1978.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1979.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1980.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1981.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1982.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1983.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1984.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1985.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1986.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1987.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1988.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1989.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1990.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1991.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1992.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1993.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1994.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1995.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1996.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1997.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1998.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
1999.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
2000.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
2001.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
2002.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
2003.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
2004.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
2005.00  (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)   (0.20)
Virtual Population Analysis using initial values

Population Numbers
             1        2        3        4        5        6        7        8        9       10      11+
1965.00 3503534 3848688  995990 1312007  348049   92556   44658    4104    1354     406      500
1966.00 2737874 2624572 2177169  784001  863223  239988   66231   35035    2855    1060      707
1967.00 6078739 2102325 1329624 1378701  575717  418512  155171   41661   21740     836     1253
1968.00 1286168 4325977 1170158  950142  889042  372334  200109   75150   30056   17430     1311
1969.00 1754254  904620 1415817  755635  702962  467578  239085   82892   32938   10845     9244
1970.00 2304087 1338027  480252  682955  499556  429512  281595  139599   47575   21258    13377
1971.00 7460417 1258574  579796  324285  303152  228973  243661  130382   77266   19947    19640
1972.00 1138007 6028985  667899  309749  169889  146502  119687  115682   61966   30575    20551
1973.00 2336523  931722 4350854  481941  121063   70132   52761   54102   51165   27434    19153
1974.00 1625829 1912063  612115 2859195  277069   63139   30305   23481   26162   20577    15921
1975.00  247148 1314489  880008  416859 1619372  165491   34561   15639   13330   10013    15485
1976.00  721820  199458  790742  505119  229479  864256   76167   17278    8846    6633    11863
1977.00 4140081  590760  113384  461878  275572  126138  466414   43093    9149    3712    10203
1978.00 1346539 3388555  345406   64483  183136  119041   57492  223170   22748    4650     6640
1979.00  449147 1070508 2428553  245946   41184   41880   36645   19392   85497    8737     5577
1980.00 1572597  367422  710839 1762596  152252   28826   13695   13722    5372   33069     5530
1981.00 1669558 1285420  289532  509412 1017308   99518   19663    7067    5380    1742    19616
1982.00 2302838 1366918  959467  191249  324646  429491   51910   13919    3261    2687    15067
1983.00 4078526 1882162 1027010  649785  136177  177675  163382   29368    9523    1459    12505
1984.00 5027282 3334258 1368174  705445  313499   89457   91079   53687   14768    6242     9665
1985.00 1831381 4115990 2650014  900962  376337  126231   52832   55107   18746    3661     3339
1986.00 1059694 1491259 3174295 1865457  466203  175953   65334   30614   28818    8199     4231
1987.00 1397308  867547 1107935 2350078 1263651  330385  115618   43794   21173   20942     8641
1988.00 1401917 1141942  635504  793142 1449860  816306  229118   77122   29291   14308    20824
1989.00 1744614 1147656  801233  418412  474051  797404  456413  149310   44098   20211    22791
1990.00 1185719 1428362  847830  553220  286868  316593  500847  304643  105751   28662    29020
1991.00  579910  970785 1008567  576914  299026  154203  168557  229416  144866   58343    31602
1992.00  824078  474790  707394  664216  307618  165457   89111   92791  115487   77777    45143
1993.00 1669807  674690  237693  459804  287340  136696   68056   42113   44305   41843    51315
1994.00  877050 1366972  483523  155220  202812  118503   53150   25557   15331   16747    47773
1995.00 1031472  717932 1025476  268195   78955   61164   32668   11627    7693    4810    29625
1996.00  913366  842844  485628  641941  119202   31801   17745    7177    3759    2545    22358
1997.00 1190214  747801  656219  363581  296445   48890   11017    6373    2929    1487    17773
1998.00  619708  974143  561228  458528  227441  125595   23094    4439    1984    1596    14426
1999.00 1704923  507250  559670  403319  250907   99434   17222    1005     282     121    11630
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Appendix C. VPA formulation and model output with German Bank acoustic index (ages 4-8).

2000.00	708686	1393439	313795	258420	197789	86303	30480	5174	279	44	9547
2001.00	1396028	579463	813807	189211	114499	51897	18599	2432	359	11	7803
2002.00	2336388	1142925	408314	375233	103608	39933	14190	1682	88	29	6387
2003.00	1808667	1898873	662950	245668	119859	18475	7989	518	26	11	5230
2004.00	903803	1480397	1117735	237472	98615	13315	3554	361	45	1	4291
2005.00	1000000	737133	923717	603204	76483	10792	2644	123	5	5	3513
2006.00	1000000	818609	538562	602250	331532	37512	5000	1225	57	2	2879

Fishing Mortality

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	0.089	0.370	0.039	0.219	0.172	0.135	0.043	0.163	0.045	0.106	0.002
1966.00	0.064	0.480	0.257	0.109	0.524	0.236	0.264	0.277	1.028	0.252	0.002
1967.00	0.140	0.386	0.136	0.239	0.236	0.538	0.525	0.127	0.021	0.490	0.139
1968.00	0.152	0.917	0.237	0.101	0.443	0.243	0.681	0.625	0.819	0.440	2.943
1969.00	0.071	0.433	0.529	0.214	0.293	0.307	0.338	0.355	0.238	0.318	0.090
1970.00	0.405	0.636	0.193	0.612	0.580	0.367	0.570	0.392	0.669	0.450	0.248
1971.00	0.013	0.434	0.427	0.446	0.527	0.449	0.545	0.544	0.727	0.533	0.383
1972.00	0.000	0.126	0.126	0.739	0.685	0.821	0.594	0.616	0.615	0.678	0.960
1973.00	0.000	0.220	0.220	0.354	0.451	0.639	0.610	0.527	0.711	0.622	1.402
1974.00	0.013	0.576	0.184	0.369	0.315	0.403	0.462	0.366	0.760	0.475	0.958
1975.00	0.014	0.308	0.355	0.397	0.428	0.576	0.493	0.370	0.498	0.545	0.579
1976.00	0.000	0.365	0.338	0.406	0.398	0.417	0.370	0.436	0.668	0.416	0.383
1977.00	0.000	0.337	0.364	0.725	0.639	0.586	0.537	0.439	0.477	0.539	0.540
1978.00	0.029	0.133	0.140	0.248	1.275	0.978	0.887	0.759	0.757	0.838	0.324
1979.00	0.001	0.209	0.121	0.280	0.157	0.918	0.782	1.084	0.750	0.830	0.639
1980.00	0.002	0.038	0.133	0.350	0.225	0.183	0.470	0.736	0.926	0.435	0.776
1981.00	0.000	0.092	0.215	0.251	0.662	0.451	0.145	0.565	0.494	0.413	0.129
1982.00	0.002	0.086	0.190	0.140	0.403	0.767	0.370	0.180	0.604	0.708	0.077
1983.00	0.001	0.119	0.176	0.529	0.220	0.468	0.913	0.487	0.222	0.655	0.124
1984.00	0.000	0.030	0.218	0.428	0.710	0.327	0.302	0.852	1.195	0.483	3.753
1985.00	0.005	0.060	0.151	0.459	0.560	0.459	0.346	0.448	0.627	0.445	0.168
1986.00	0.000	0.097	0.101	0.190	0.144	0.220	0.200	0.169	0.119	0.201	0.095
1987.00	0.002	0.111	0.134	0.283	0.237	0.166	0.205	0.202	0.192	0.179	0.087
1988.00	0.000	0.154	0.218	0.315	0.398	0.381	0.228	0.359	0.171	0.344	0.163
1989.00	0.000	0.103	0.170	0.177	0.204	0.265	0.204	0.145	0.231	0.232	0.160
1990.00	0.000	0.148	0.185	0.415	0.421	0.430	0.581	0.543	0.395	0.517	0.300
1991.00	0.000	0.117	0.218	0.429	0.392	0.348	0.397	0.486	0.422	0.421	0.630
1992.00	0.000	0.492	0.231	0.638	0.597	0.688	0.550	0.539	0.815	0.663	0.691
1993.00	0.000	0.133	0.226	0.619	0.686	0.759	0.779	0.810	0.773	0.773	0.273
1994.00	0.000	0.087	0.389	0.476	0.999	1.089	1.320	1.001	0.959	1.126	0.440
1995.00	0.002	0.191	0.268	0.611	0.709	1.037	1.315	0.929	0.906	1.098	0.142
1996.00	0.000	0.050	0.089	0.573	0.691	0.860	0.824	0.696	0.727	0.822	0.082
1997.00	0.000	0.087	0.158	0.269	0.659	0.550	0.709	0.967	0.407	0.608	0.056
1998.00	0.000	0.354	0.130	0.403	0.627	1.787	2.934	2.558	2.597	1.990	0.031
1999.00	0.002	0.280	0.573	0.513	0.844	0.982	1.003	1.082	1.657	0.988	0.001
2000.00	0.001	0.338	0.306	0.614	1.138	1.358	2.328	2.468	3.009	1.646	0.003
2001.00	0.000	0.150	0.574	0.402	0.853	1.097	2.203	3.121	2.321	1.451	0.001
2002.00	0.007	0.345	0.308	0.941	1.524	1.409	3.110	3.973	1.919	1.919	0.001
2003.00	0.000	0.330	0.827	0.713	1.997	1.448	2.898	2.251	2.811	0.000	0.000
2004.00	0.004	0.272	0.417	0.933	2.012	1.417	3.160	4.071	1.983	1.832	0.000
2005.00	0.000	0.114	0.228	0.399	0.512	0.569	0.569	0.569	0.569	0.569	0.000

LAMBDA   1.00000E92
RSS   1.78222E1
NPHI   1.78222E1

Parameters
  8.51719E0

LAMBDA   1.00000E93
RSS   1.71891E1
NPHI   1.71891E1

Parameters
  8.11718E0

LAMBDA   1.00000E94
RSS   1.71338E1
NPHI   1.71338E1

Parameters
  7.99328E0

LAMBDA   1.00000E95
RSS   1.71289E1

Appendix C. VPA formulation and model output with German Bank acoustic index (ages 4-8).

```
NPHI          1.71289E1

Parameters
   7.95594E0
LAMBDA        1.00000Eý5
RSS           1.71285E1
NPHI          1.71285E1

Parameters
   7.94481E0

LAMBDA        1.00000Eý5
RSS           1.71285E1
NPHI          1.71285E1

Parameters
   7.94151E0


RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN 0.00001

LAMBDA        1.00000Eý2
RSS           1.71285E1
NPHI          1.71285E1

Parameters
   7.94151E0      1.32313E0      2.34044E0      2.47156E0      3.43131E0      3.54228E0

LAMBDA        1.00000Eý3
RSS           1.71285E1
NPHI          1.71285E1

Parameters
   7.94053E0      1.32329E0      2.34060E0      2.47171E0      3.43146E0      3.54244E0

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN 0.00001

Estimated VPA (biased)

Population Numbers
             1        2        3        4        5        6        7        8        9       10      11+
1965.00 3503534 3848688  995990 1312007  348049   92556   44658    4104    1354     406      500
1966.00 2737874 2624572 2177169  784001  863223  239988   66231   35035    2855    1060      707
1967.00 6078739 2102325 1329624 1378701  575717  418512  155171   41661   21740     836     1253
1968.00 1286168 4325977 1170158  950142  889042  372334  200109   75150   30056   17430     1311
1969.00 1754254  904620 1415817  755635  702962  467578  239085   82892   32938   10845     9244
1970.00 2304087 1338027  480252  682955  499558  429512  281595  139599   47575   21258    13377
1971.00 7460417 1258574  579796  324285  303152  228973  243661  130382   77266   19947    19640
1972.00 1138007 6028985  667899  309749  169889  146502  119687  115682   61966   30575    20551
1973.00 2336523  931722 4350854  481941  121063   70132   52761   54102   51165   27434    19153
1974.00 1625829 1912063  612115 2859195  277069   63139   30305   23481   26162   20577    15921
1975.00  247148 1314489  880008  416859 1619372  165491   34561   15639   13330   10013    15485
1976.00  721820  199458  790742  505119  229479  864256   76167   17278    8846    6633    11863
1977.00 4140081  590760  113384  461878  275572  126138  466414   43093    9149    3712    10203
1978.00 1346539 3388555  345406   64483  183136  119041   57492  223170   22748    4650     6640
1979.00  449147 1070508 2428553  245946   41184   41880   36645   19392   85497    8737     5577
1980.00 1572597  367422  710839 1762596  152252   28826   13695   13722    5372   33069     5530
1981.00 1669558 1285420  289532  509412 1017308   99518   19663    7007    5380    1742    19616
1982.00 2302838 1366918  959467  191249  324646  429491   51910   13919    3261    2687    15067
1983.00 4078526 1882162 1027010  649785  136177  177675  163382   29368    9523    1459    12505
1984.00 5027282 3334258 1368174  705445  313499   89457   91079   53687   14768    6242     9665
1985.00 1831381 4115990 2650014  900962  376337  126231   52832   55107   18746    3661     3339
1986.00 1059694 1491259 3174295 1865457  466203  175953   65334   30614   28818    8199     4231
1987.00 1397308  867547 1107935 2350078 1263651  330385  115618   43794   21173   20942     8641
1988.00 1401917 1141942  635504  793142 1449860  816306  229118   77122   29291   14308    20824
1989.00 1744614 1147656  801233  418412  474051  797404  456413  149310   44098   20211    22791
1990.00 1185719 1428362  847830  553220  286868  316593  500847  304643  105751   28662    29020
1991.00  579910  970785 1008567  576914  299026  154203  168557  229416  144866   58343    31602
1992.00  824078  474790  707394  664216  307618  165457   89111   92791  115487   77777    45143
1993.00 1669807  674690  237693  459804  287340  138696   68056   42113   44305   41843    51315
1994.00  877050 1366972  483523  155220  202812  118503   53150   25557   15331   16747    47773
1995.00 1031471  717932 1025476  268195   78955   61164   32668   11627    7693    4810    29629
1996.00  913354  842843  485628  641941  119202   31801   17745    7177    3759    2545    22358
1997.00 1190202  747791  656219  363580  296445   48890   11017    6373    2929    1487    17773
1998.00  619538  974133  561220  458528  227441  125595   23094    4439    1984    1596    14426
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1999.00	1702410	507111	559662	403313	250907	99434	17222	1005	282	121	11630
2000.00	700638	1391382	313682	258413	197784	88303	30480	5174	279	44	9547
2001.00	1350681	572875	812126	189118	114494	51893	18599	2432	359	11	7803
2002.00	2032796	1105798	402922	373864	103532	39928	14187	1682	88	29	6387
2003.00	1393923	1650313	632615	241280	118755	18415	7986	516	26	11	5230
2004.00	617184	1140833	914664	212938	95037	12475	3506	358	43	1	4291
2005.00	1000000	502469	646167	437560	56746	8094	1983	93	4	4	3513
2006.00	1000000	818609	346497	375305	196450	21458	2809	688	32	1	2877

Fishing Mortality

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	0.089	0.370	0.039	0.219	0.172	0.135	0.043	0.163	0.045	0.106	0.002
1966.00	0.064	0.480	0.257	0.109	0.524	0.236	0.264	0.277	1.028	0.252	0.002
1967.00	0.140	0.386	0.136	0.239	0.236	0.538	0.525	0.127	0.021	0.490	0.139
1968.00	0.152	0.917	0.237	0.101	0.443	0.243	0.681	0.625	0.819	0.440	2.943
1969.00	0.071	0.433	0.529	0.214	0.293	0.307	0.338	0.355	0.238	0.318	0.090
1970.00	0.405	0.636	0.193	0.612	0.580	0.367	0.570	0.392	0.669	0.450	0.248
1971.00	0.013	0.434	0.427	0.446	0.527	0.449	0.545	0.544	0.727	0.533	0.383
1972.00	0.000	0.126	0.126	0.739	0.685	0.821	0.594	0.616	0.615	0.678	0.960
1973.00	0.000	0.220	0.220	0.354	0.451	0.639	0.610	0.527	0.711	0.622	1.402
1974.00	0.013	0.576	0.184	0.369	0.315	0.403	0.462	0.366	0.760	0.475	0.958
1975.00	0.014	0.308	0.355	0.397	0.426	0.576	0.493	0.370	0.498	0.545	0.579
1976.00	0.000	0.365	0.338	0.406	0.398	0.417	0.370	0.436	0.668	0.416	0.383
1977.00	0.000	0.337	0.364	0.725	0.639	0.586	0.537	0.439	0.477	0.539	0.540
1978.00	0.029	0.133	0.140	0.248	1.275	0.978	0.887	0.759	0.757	0.838	0.324
1979.00	0.001	0.209	0.121	0.280	0.157	0.918	0.782	1.084	0.750	0.830	0.639
1980.00	0.002	0.038	0.133	0.350	0.225	0.183	0.470	0.736	0.926	0.435	0.776
1981.00	0.000	0.092	0.133	0.251	0.662	0.451	0.145	0.565	0.494	0.413	0.129
1982.00	0.002	0.086	0.215	0.140	0.403	0.767	0.370	0.180	0.604	0.708	0.077
1983.00	0.001	0.119	0.190	0.529	0.220	0.468	0.913	0.487	0.222	0.655	0.124
1984.00	0.000	0.030	0.176	0.428	0.710	0.327	0.302	0.852	1.195	0.483	3.753
1985.00	0.005	0.060	0.218	0.459	0.560	0.459	0.346	0.448	0.627	0.445	0.168
1986.00	0.000	0.097	0.151	0.190	0.144	0.220	0.200	0.169	0.119	0.201	0.095
1987.00	0.002	0.111	0.101	0.283	0.237	0.166	0.205	0.202	0.192	0.179	0.087
1988.00	0.000	0.154	0.134	0.315	0.398	0.381	0.228	0.359	0.171	0.344	0.163
1989.00	0.000	0.103	0.218	0.177	0.204	0.265	0.204	0.145	0.231	0.232	0.160
1990.00	0.000	0.148	0.170	0.415	0.421	0.430	0.581	0.543	0.395	0.517	0.300
1991.00	0.000	0.117	0.185	0.429	0.392	0.348	0.397	0.486	0.422	0.421	0.630
1992.00	0.000	0.492	0.218	0.638	0.597	0.688	0.550	0.539	0.815	0.663	0.691
1993.00	0.000	0.133	0.231	0.619	0.686	0.759	0.779	0.810	0.773	0.773	0.273
1994.00	0.000	0.087	0.226	0.476	0.999	1.089	1.320	1.001	0.959	1.126	0.440
1995.00	0.002	0.191	0.389	0.611	0.709	1.037	1.315	0.929	0.906	1.098	0.142
1996.00	0.000	0.050	0.268	0.573	0.691	0.860	0.824	0.646	0.727	0.822	0.082
1997.00	0.000	0.087	0.089	0.269	0.659	0.550	0.709	0.967	0.407	0.608	0.056
1998.00	0.000	0.354	0.158	0.403	0.627	1.787	2.934	2.558	2.597	1.990	0.031
1999.00	0.002	0.280	0.130	0.513	0.844	0.982	1.003	1.082	1.657	0.988	0.001
2000.00	0.001	0.338	0.573	0.614	1.138	1.358	2.328	2.468	3.009	1.646	0.003
2001.00	0.000	0.152	0.306	0.402	0.853	1.097	2.203	3.121	2.321	1.451	0.001
2002.00	0.008	0.358	0.576	0.947	1.527	1.409	3.114	3.976	1.920	1.920	0.001
2003.00	0.000	0.390	0.313	0.732	2.053	1.459	2.904	2.285	2.853	0.000	0.000
2004.00	0.006	0.368	0.889	1.122	2.263	1.639	3.435	4.353	2.232	2.084	0.000
2005.00	0.000	0.172	0.537	0.601	0.772	0.858	0.858	0.858	0.858	0.858	0.000

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET......... 0.001200
MEAN SQUARE RESIDUALS 0.590637

Parameter	Est.	Std. Err.	Rel. Err.	Bias	Rel. Bias
N[2006 7]	2.81E3	1.32E3	0.471	2.66E2	0.095
q ID#[3]	3.76E0	1.13E0	0.301	1.58E9-1	0.042
q ID#[4]	1.04E1	3.12E0	0.300	4.44E9-1	0.043
q ID#[5]	1.18E1	3.55E0	0.300	5.13E9-1	0.043
q ID#[6]	3.09E1	9.27E0	0.300	1.34E0	0.043
q ID#[7]	3.46E1	1.04E1	0.300	1.50E0	0.043

VPA using analytical bias adjusted parameters (linear scale)
Population Numbers

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	3503534	3848688	995990	1312007	348049	92556	44658	4104	1354	406	500
1966.00	2737874	2624572	2177169	784001	863223	239988	66231	41661	21740	836	1253
1967.00	6078739	2102325	1329624	1378701	575717	418512	155171	75150	30056	17430	1311
1968.00	1286168	4325977	1170158	950142	889042	372334	200109	62692	32938	10845	9244
1969.00	1754254	904620	1415817	755635	702962	467578	239085				

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1970.00	2304087	1338027	480252	682955	499558	429512	281595	139599	47575	21258	13377
1971.00	7460417	1258574	579796	324285	303152	228973	243661	130382	77266	19947	19640
1972.00	1138007	6028985	667899	309749	169889	146502	119687	115682	61966	30575	20551
1973.00	2336523	931722	4350854	481941	121063	70132	52761	54102	51165	27434	19153
1974.00	1625829	1912063	612115	2859195	277069	63139	30305	23481	26162	20577	15921
1975.00	247148	1314489	880008	416859	1619372	165491	34561	15639	13330	10013	15485
1976.00	721820	199458	790742	505119	229479	864256	76167	17278	8846	6633	11863
1977.00	4140081	590760	113384	461878	275572	126138	466414	43093	9149	3712	10203
1978.00	1346539	3388555	345406	64483	183136	119041	57492	223170	22748	4650	6640
1979.00	449147	1070508	2428553	245946	41184	41880	36645	19392	85497	8737	5577
1980.00	1572597	367422	710839	1762596	152252	28826	13695	13722	5372	33069	5530
1981.00	1669558	1285420	289532	509412	1017308	99518	19663	7007	5380	1742	19616
1982.00	2302838	1366918	959467	191249	324646	429491	51910	13919	3261	2687	15067
1983.00	4078526	1682162	1027010	649785	136177	177675	163382	29368	9523	1459	12505
1984.00	5027282	3334258	1368174	705445	313499	89457	91079	53687	14768	6242	9665
1985.00	1831381	4115990	2650014	900962	376337	126231	52832	55107	18746	3661	3339
1986.00	1059694	1491259	3174295	1865457	466203	175953	65334	30614	28818	8199	4231
1987.00	1397308	867547	1107935	2350078	1263651	330385	115618	43794	21173	20942	8641
1988.00	1401917	1141942	635504	793142	1449860	816306	229118	77122	29291	14308	20824
1989.00	1744614	1147656	801233	418412	474051	797404	456413	149310	44098	20211	22791
1990.00	1185719	1428362	847830	553220	286868	316593	500847	304643	105751	28662	29020
1991.00	579910	970785	1008567	576914	299026	154203	168557	229416	144866	58343	31602
1992.00	824078	474790	707394	664216	307618	165457	89111	92791	115487	77777	45143
1993.00	1669807	674690	237693	459804	287340	138696	68056	42113	44305	41843	51315
1994.00	877050	1366972	483523	155220	202812	118503	53150	25557	15331	16747	47773
1995.00	1031471	717932	1025476	268195	78955	61164	32668	11627	7693	4810	29629
1996.00	913353	842843	485628	641941	119202	31801	17745	7177	3759	2545	22358
1997.00	1190201	747790	656218	363580	296445	48890	11017	6373	2929	1487	17773
1998.00	619517	974132	561219	458527	227441	125595	23094	4439	1984	1596	14426
1999.00	1702100	507094	559661	403312	250907	99434	17222	1005	282	121	11630
2000.00	699645	1391128	313667	258412	197783	88303	30480	5174	279	44	9547
2001.00	1345106	572061	811919	189106	114493	51893	18599	2432	359	11	7803
2002.00	1995355	1101234	402256	373696	103522	39928	14187	1682	88	29	6387
2003.00	1342461	1619659	628886	240736	118619	88408	7985	516	26	11	5230
2004.00	581550	1098699	889632	209925	94595	12372	3500	358	43	1	4291
2005.00	1000000	473295	611752	417166	54332	7765	1902	89	4	4	3513
2006.00	1000000	818609	322624	347187	179860	19503	2543	623	29	1	2877

Fishing Mortality

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	0.089	0.370	0.039	0.219	0.172	0.135	0.043	0.163	0.045	0.106	0.002
1966.00	0.064	0.480	0.257	0.109	0.524	0.236	0.264	0.277	1.028	0.252	0.002
1967.00	0.140	0.386	0.136	0.239	0.236	0.538	0.525	0.127	0.021	0.490	0.139
1968.00	0.152	0.917	0.237	0.101	0.443	0.243	0.681	0.625	0.819	0.440	2.943
1969.00	0.071	0.433	0.529	0.214	0.293	0.307	0.338	0.355	0.238	0.318	0.090
1970.00	0.405	0.636	0.193	0.612	0.580	0.367	0.570	0.392	0.669	0.450	0.248
1971.00	0.013	0.434	0.427	0.446	0.527	0.449	0.545	0.544	0.727	0.533	0.383
1972.00	0.000	0.126	0.126	0.739	0.685	0.821	0.594	0.616	0.615	0.678	0.960
1973.00	0.000	0.220	0.220	0.354	0.451	0.639	0.610	0.527	0.711	0.622	1.402
1974.00	0.013	0.576	0.184	0.369	0.315	0.403	0.462	0.366	0.760	0.475	0.958
1975.00	0.014	0.308	0.355	0.397	0.428	0.576	0.493	0.370	0.498	0.545	0.579
1976.00	0.000	0.365	0.338	0.406	0.398	0.417	0.370	0.436	0.668	0.416	0.383
1977.00	0.000	0.337	0.364	0.725	0.639	0.586	0.537	0.439	0.477	0.539	0.540
1978.00	0.029	0.133	0.140	0.248	1.275	0.978	0.887	0.759	0.757	0.838	0.324
1979.00	0.001	0.209	0.121	0.280	0.157	0.918	0.782	1.084	0.750	0.830	0.639
1980.00	0.002	0.038	0.133	0.350	0.225	0.183	0.470	0.736	0.926	0.435	0.776
1981.00	0.000	0.092	0.215	0.251	0.662	0.451	0.145	0.565	0.494	0.413	0.129
1982.00	0.002	0.086	0.190	0.140	0.403	0.767	0.370	0.180	0.604	0.708	0.077
1983.00	0.001	0.119	0.176	0.529	0.220	0.468	0.913	0.487	0.222	0.655	0.124
1984.00	0.000	0.030	0.218	0.428	0.710	0.327	0.302	0.852	1.195	0.483	3.753
1985.00	0.005	0.060	0.151	0.459	0.560	0.459	0.346	0.448	0.627	0.445	0.168
1986.00	0.000	0.097	0.101	0.190	0.144	0.220	0.200	0.169	0.119	0.201	0.095
1987.00	0.002	0.111	0.134	0.283	0.237	0.166	0.205	0.202	0.192	0.179	0.087
1988.00	0.000	0.154	0.218	0.315	0.398	0.381	0.228	0.359	0.171	0.344	0.163
1989.00	0.000	0.103	0.170	0.177	0.204	0.265	0.204	0.145	0.231	0.232	0.160
1990.00	0.000	0.148	0.185	0.415	0.421	0.430	0.581	0.543	0.395	0.517	0.300
1991.00	0.000	0.117	0.218	0.429	0.392	0.348	0.397	0.486	0.422	0.421	0.630
1992.00	0.000	0.492	0.231	0.636	0.597	0.688	0.550	0.539	0.815	0.663	0.691
1993.00	0.000	0.133	0.226	0.619	0.686	0.759	0.779	0.810	0.773	0.773	0.273
1994.00	0.000	0.087	0.389	0.476	0.999	1.089	1.320	1.001	0.959	1.126	0.440
1995.00	0.002	0.191	0.268	0.611	0.709	1.037	1.315	0.929	0.906	1.098	0.142
1996.00	0.000	0.050	0.089	0.573	0.691	0.860	0.824	0.696	0.727	0.822	0.082
1997.00	0.000	0.087	0.158	0.269	0.659	0.709	0.550	0.967	0.407	0.608	0.056
1998.00	0.000	0.354	0.130	0.403	0.627	1.787	2.934	2.558	2.597	1.990	0.031
1999.00	0.002	0.280	0.573	0.513	0.844	0.982	1.003	1.082	1.657	0.988	0.001

Appendix C. VPA formulation and model output with German Bank acoustic index (ages 4-8).

```
2000.00   0.001   0.338   0.306   0.614   1.138   1.358   2.328   2.468   3.009   1.646   0.003
2001.00   0.000   0.152   0.576   0.403   0.853   1.097   2.203   3.121   2.321   1.451   0.001
2002.00   0.009   0.360   0.313   0.948   1.527   1.409   3.114   3.977   1.920   1.920   0.001
2003.00   0.000   0.399   0.897   0.734   2.061   1.460   2.905   2.289   2.858   0.000   0.000
2004.00   0.006   0.386   0.557   1.152   2.300   1.672   3.475   4.393   2.269   2.121   0.000
2005.00   0.000   0.183   0.366   0.641   0.825   0.916   0.916   0.916   0.916   0.916   0.000
```

German Only Acoustic
Age :   4
Ln calibration constant :   1.32329

Year	Observed	Predicted	Residual	Ln Pop.
1999.65	12.96753	13.76760	-0.80007	12.44432
2000.65	13.16991	13.25648	-0.08657	11.93319
2001.65	12.13023	13.08179	-0.95156	11.75851
2002.65	14.13044	13.40949	0.72095	12.08621
2003.65	13.28892	13.11139	0.17753	11.78811
2004.65	13.78289	12.73241	1.05048	11.40913
2005.65	13.68104	13.79161	-0.11057	12.46832

          Average squared residual :   0.46001

German Only Acoustic
Age :   5
Ln calibration constant :   2.34060

Year	Observed	Predicted	Residual	Ln Pop.
1999.65	13.93920	14.09463	-0.15544	11.75404
2000.65	13.51565	13.66584	-0.15019	11.32524
2001.65	12.02610	13.30414	-1.27804	10.96354
2002.65	12.99544	12.76587	0.22957	10.42528
2003.65	13.11189	12.56072	0.55117	10.22012
2004.65	13.25515	12.20149	1.05365	9.86090
2005.65	12.40416	12.65470	-0.25054	10.31411

          Average squared residual :   0.45851

German Only Acoustic
Age :   6
Ln calibration constant :   2.47171

Year	Observed	Predicted	Residual	Ln Pop.
1999.65	13.40713	13.21038	0.19675	10.73867
2000.65	12.79640	12.84776	-0.05137	10.37605
2001.65	11.62979	12.48570	-0.85592	10.01399
2002.65	12.02526	12.02043	0.00483	9.54872
2003.65	11.18338	11.21456	-0.03118	8.74284
2004.65	11.48017	10.70765	0.77253	8.23593
2005.65	10.74706	10.78252	-0.03547	8.31081

          Average squared residual :   0.19614

German Only Acoustic
Age :   7
Ln calibration constant :   3.43146

Year	Observed	Predicted	Residual	Ln Pop.
1999.65	12.00333	12.40375	-0.40042	8.97229
2000.65	11.95667	12.11286	-0.15619	8.68139
2001.65	11.03088	11.70036	-0.66948	8.26889
2002.65	11.41724	10.83756	0.57968	7.40610
2003.65	10.50934	10.39935	0.10999	6.96789
2004.65	10.51886	9.23114	1.28772	5.79967
2005.65	9.58458	10.33571	-0.75113	6.90424

          Average squared residual :   0.45764

German Only Acoustic
Age :   8
Ln calibration constant :   3.54244

Appendix C. VPA formulation and model output with German Bank acoustic index (ages 4-8).

Year	Observed	Predicted	Residual	Ln Pop.
1999.65	8.62361	9.62215	-0.99854	6.07971
2000.65	10.17591	10.35969	-0.18378	6.81725
2001.65	9.42545	9.18023	0.24522	5.63779
2002.65	9.51488	8.25575	1.25913	4.71331
2003.65	7.44813	8.17343	-0.72531	4.63099
2004.65	7.85774	6.46469	1.39305	2.92225
2005.65	6.39236	7.38196	-0.98960	3.83952

Average squared residual :   0.87463

German Only Acoustic 4 Abundance Proportional
German Only Acoustic 5 Abundance Proportional
German Only Acoustic 6 Abundance Proportional
German Only Acoustic 7 Abundance Proportional
German Only Acoustic 8 Abundance Proportional
Autocorrelation : 0.6443143662

```
   1.00 ŷ0.26 ŷ0.26 ŷ0.25 ŷ0.25 ŷ0.25
ŷ0.26  1.00  0.07  0.06  0.06  0.06
ŷ0.26  0.07  1.00  0.06  0.06  0.06
ŷ0.25  0.06  0.06  1.00  0.06  0.06
ŷ0.25  0.06  0.06  0.06  1.00  0.06
ŷ0.25  0.06  0.06  0.06  0.06  1.00
```

Projection results using analytical bias adjusted point estimates
Projected Population Numbers

	1	2	3	4	5	6	7	8	9	10	11+
2006.00	1000000	818609	322624	347187	179860	19503	2543	623	29	1	2877
2007.00	1000000	818731	640345	241118	242321	119938	12712	1658	406	19	1876

Fishing Mortality

	1	2	3	4	5	6	7	8	9	10	11+
2006.00	0.000	0.046	0.091	0.160	0.205	0.228	0.228	0.228	0.228	0.228	0.228

M

	1	2	3	4	5	6	7	8	9	10	11
2006.00	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

PR

	1	2	3	4	5	6	7	8	9	10	11
2006.00	0.00	0.20	0.40	0.70	0.90	1.00	1.00	1.00	1.00	1.00	1.00

Beg wt

	1	2	3	4	5	6	7	8	9	10	11
2006.00	0.02	0.02	0.05	0.11	0.16	0.21	0.25	0.28	0.31	0.35	0.35
2007.00	0.02	0.02	0.05	0.11	0.16	0.21	0.25	0.28	0.31	0.35	0.35

Projected Population Biomass

	1	2	3	4	5	6	7	8	9	10	11
2006.00	19046	15845	17358	38404	29290	4100	627	176	9	0	1019
2007.00	19046	15847	34451	26671	39462	25215	3132	469	126	7	665

```
1+       2+      3+       4+
 2006.00 ...
125874  106828   90983   73626
 2007.00 ...
165092  146046  130198   95747
```

Projected Catch Numbers

	1	2	3	4	5	6	7	8	9	10	11
2006.00	0	33098	25527	46542	30345	3618	472	116	5	0	534
2007.00											

Avg wt

	1	2	3	4	5	6	7	8	9	10	11
2006.00	0.02	0.03	0.08	0.14	0.19	0.23	0.26	0.31	0.32	0.36	0.36

Projected Catch Biomass

Appendix C. VPA formulation and model output with German Bank acoustic index (ages 4-8).

```
              1         2         3         4         5         6         7         8         9        10        11
1+      2+      3+      4+
 2006.00       0      1150      2125      6558      5809       841       125        35         2         0       195
16839   16839   15690   13565
 2007.00
```

Input for Analytical risk analysis of projection results

M

```
              1         2         3         4         5         6         7         8         9        10        11
 2006.00    0.20      0.20      0.20      0.20      0.20      0.20      0.20      0.20      0.20      0.20      0.20
```

PR

```
              1         2         3         4         5         6         7         8         9        10        11
 2006.00    0.00      0.20      0.40      0.70      0.90      1.00      1.00      1.00      1.00      1.00      1.00
```

Beg wt

```
              1         2         3         4         5         6         7         8         9        10        11
 2006.00    0.02      0.02      0.05      0.11      0.16      0.21      0.25      0.28      0.31      0.35      0.35
 2007.00    0.02      0.02      0.05      0.11      0.16      0.21      0.25      0.28      0.31      0.35      0.35
```

Avg wt

```
              1         2         3         4         5         6         7         8         9        10        11
 2006.00    0.02      0.03      0.08      0.14      0.19      0.23      0.26      0.31      0.32      0.36      0.36
```

Maturity

```
              1         2         3         4         5         6         7         8         9        10        11
 2006.00    0.00      0.00      0.50      0.90      1.00      1.00      1.00      1.00      1.00      1.00      1.00
 2007.00    0.00      0.00      0.50      0.90      1.00      1.00      1.00      1.00      1.00      1.00      1.00
```

```
            Inverse Exploitation Rate (Reference = 5.39 )
 Quota    Mean Std. Err.      Bias Adj. Mean        Prob
 10000    9.661    3.764      0.753     8.908      0.175
 20000    4.912    1.914      0.383     4.529      0.674
 30000    3.334    1.299      0.260     3.074      0.963
 40000    2.549    0.993      0.199     2.351      0.999
 50000    2.083    0.811      0.162     1.920      1.000
 60000    1.775    0.692      0.138     1.637      1.000
 70000    1.560    0.608      0.122     1.438      1.000
 80000    1.402    0.546      0.109     1.293      1.000
 90000    1.285    0.500      0.100     1.185      1.000
100000    1.196    0.466      0.093     1.103      1.000
110000    1.129    0.440      0.088     1.041      1.000
```

```
            % Biomass Change (Reference = 0 )
 Quota    Mean Std. Err.      Bias Adj. Mean        Prob
 10000      48        5          1        47       0.000
 20000      36        0          0        36       0.000
 30000      25        4         -1        26       0.000
 40000      13        9         -2        15       0.042
 50000       2       13         -3         4       0.373
 60000     -10       17         -3        -6       0.647
 70000     -21       21         -4       -17       0.789
 80000     -32       25         -4       -28       0.865
 90000     -43       29         -4       -39       0.909
100000     -54       32         -4       -50       0.940
110000     -65       35         -1       -64       0.965
```

```
            Biomass (Reference = 100000 )
 Quota    Mean Std. Err.      Bias Adj. Mean        Prob
 10000   126120    44804       8339    117781      0.346
 20000   116155    44783       8345    107810      0.431
 30000   106232    44745       8356     97876      0.519
 40000    96359    44682       8378     87981      0.606
 50000    86545    44587       8417     78128      0.688
 60000    76800    44446       8487     68313      0.762
 70000    67140    44239       8611     58528      0.826
 80000    57584    43933       8843     48741      0.878
 90000    48161    43470       9298     38863      0.920
100000    38915    42739      10282     28633      0.953
110000    29911    41501      12718     17193      0.977
```

Appendix C. VPA formulation and model output with German Bank acoustic index (ages 4-8).